Using a DOT's Intergraph Data in an ESRI Environment

Chris Markel

GeoDecisions

April 11, 2001

GEODECISIONS

Interoperability – Why?

- There are very few single-vendor DOTs anymore.
- DOTs have multiple platforms and products, intentionally or not
  - "Best tool for the job"
- DOTs have to work together with local partners
- Everything has to work together, eventually.

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Interoperability – Why?

Intergraph-based DOTs are adding ESRI and other GIS products

- ArcView or ArcInfo for environmental analysis
- TransCAD for modeling and distance matrices

ESRI-based DOTs are adding Intergraph and other GIS products

- WebMap for information delivery
- Spatial RDBMS tools for management

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Interoperability – Why?

DOTs, MPOs, RPCs, Counties, other state agencies, other planning groups all find themselves having to share data and processes

- Framework data
- Transportation management systems
- ITS

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Interoperability - Focus

Intergraph-based DOTs have to share data with partners who use ESRI products

- Internal & external

The data is roadway-based

- Graphic data are road centerlines
- The partner wants to use the DOT's attribute data
- Linear Referencing System (LRS) is used to locate data

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GeoDecisions Approach

Develop Transportation Information Systems to distribute DOT data to MPO, LDD, and County planning groups

Distribute data to other Department groups

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Interoperability - Assumptions

The agency GIS is Intergraph's MGE

- Segment Manager for the LRS
- LRS is NLF-ID, Begin, End
  - Could be Begin and Length, etc.
- RIS for attribute data to an RDBMS
- GeoMedia for data translation

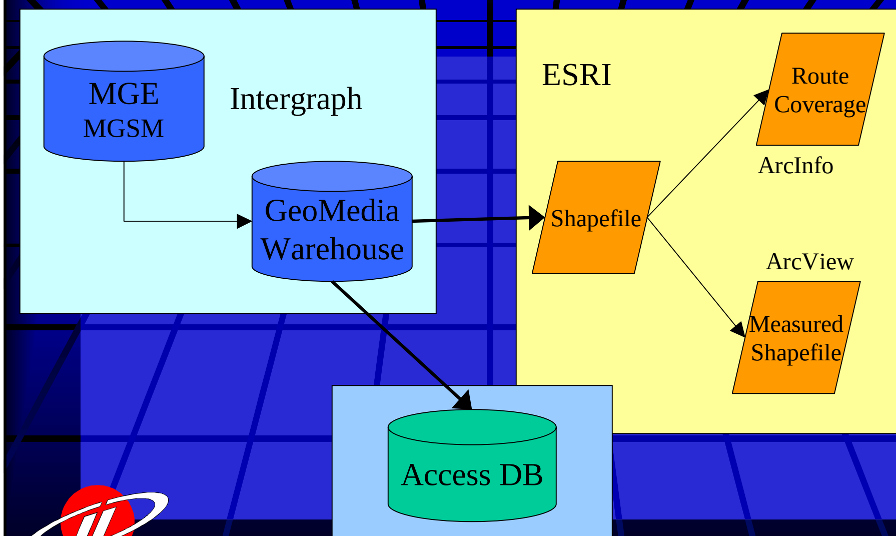
Interoperability - Assumptions

The partner is using ArcView or ArcInfo

- LRS route system(s) constructed in ArcInfo (Workstation), or
- Measured shapefiles built in ArcView (3.x)
- Data use in ArcInfo or ArcView

Assume no SDE or ArcGIS use now

How To Do It - Briefly



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How To Do It - Intergraph

Use GeoMedia to create a warehouse from the MGE project

- Load the roads and LRS from Segment Manager
- Create Access tables to hold the needed attribute information, with LRS keys
- Output a shapefile with the NLF-ID field, begin and end measures
- Send the Access database and shapefile files to the partner

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How To Do It - ESRI

Construct a Route Coverage

- Convert shapefile to line coverage
- Create route system

The following steps should be completed in ArcInfo. This assumes a shapefile called lrs_rt_1099 has been provided from GeoMedia or by other means and has at least the line data fields lrs_key, beg_cnty_l, end_cnty_l. An ArcInfo coverage can also be used, eliminating the first step.

Arc: shapearc lrs_rt_1099 lrsrt – create the coverage lrsrt from the shapefile.

Create the ArcInfo route system using the LRS identifier and appropriate route measurements.

Arc: arcsection lrsrt cntyl lrs_key beg_cnty_l end_cnty_l

lrsrt – LRS coverage
cntyl – the route system; this can be any name
lrs_key – LRS identifier
beg_cnty_l – LRS beginning route measure
end_cnty_l – LRS ending route measure

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How To Do It - ESRI

Construct a Measured Shapefile

- Convert shapefile as PolyLine to PolyLineM
- Interpolate Begin and End measures to the PolyLineM
- Requires Avenue coding scripts

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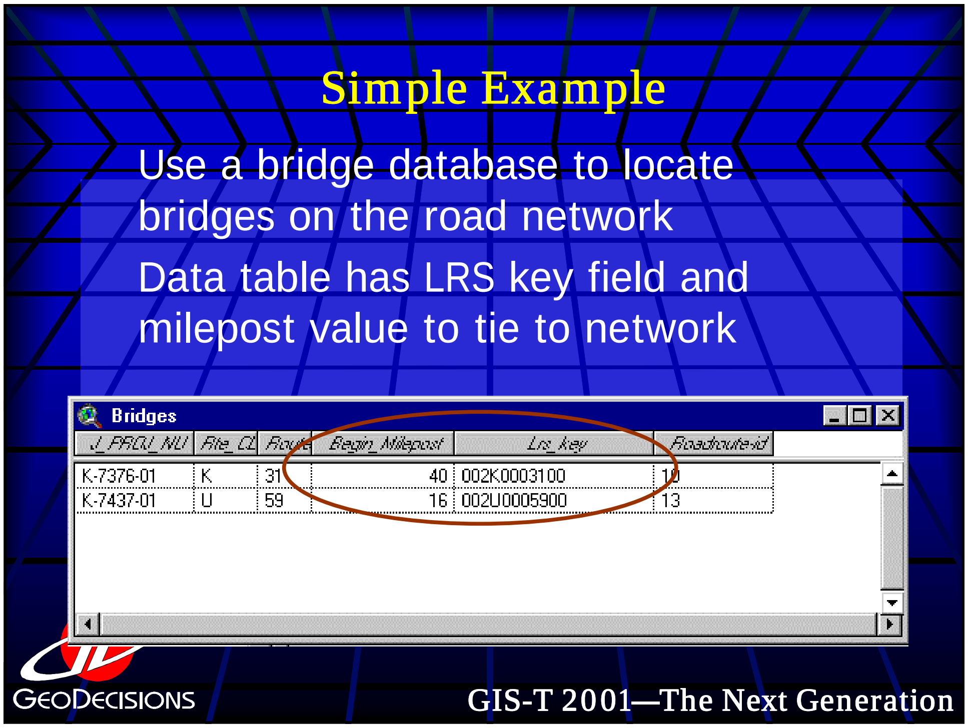
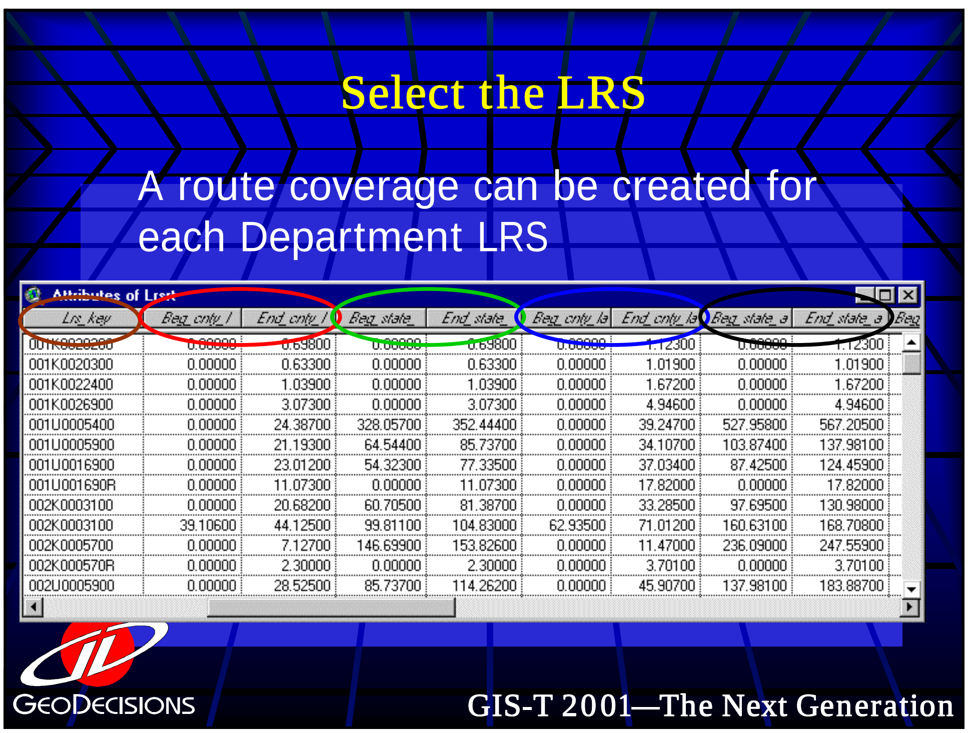


J_PROJ_NU	Rte_CL	Route	Begin_Milepost	Lrs_key	Roadroute-id
K-7376-01	K	31	40	002K0003100	10
K-7437-01	U	59	16	002U0005900	13



Lrs_key	Beg_cnty_l	End_cnty_l	Beg_state_	End_state_	Beg_cnty_la	End_cnty_la	Beg_state_a	End_state_a	Beg
001K0020200	0.00000	0.69800	0.00000	0.69800	0.00000	1.12300	0.00000	1.12300	
001K0020300	0.00000	0.63300	0.00000	0.63300	0.00000	1.01900	0.00000	1.01900	
001K0022400	0.00000	1.03900	0.00000	1.03900	0.00000	1.67200	0.00000	1.67200	
001K0026900	0.00000	3.07300	0.00000	3.07300	0.00000	4.94600	0.00000	4.94600	
001U0005400	0.00000	24.38700	328.05700	352.44400	0.00000	39.24700	527.95800	567.20500	
001U0005900	0.00000	21.19300	64.54400	85.73700	0.00000	34.10700	103.87400	137.98100	
001U0016900	0.00000	23.01200	54.32300	77.33500	0.00000	37.03400	87.42500	124.45900	
001U001690R	0.00000	11.07300	0.00000	11.07300	0.00000	17.82000	0.00000	17.82000	
002K0003100	0.00000	20.68200	60.70500	81.38700	0.00000	33.28500	97.69500	130.98000	
002K0003100	39.10600	44.12500	99.81100	104.83000	62.93500	71.01200	160.63100	168.70800	
002K0005700	0.00000	7.12700	146.69900	153.82600	0.00000	11.47000	236.09000	247.55900	
002K000570R	0.00000	2.30000	0.00000	2.30000	0.00000	3.70100	0.00000	3.70100	
002U0005900	0.00000	28.52500	85.73700	114.26200	0.00000	45.90700	137.98100	183.88700	

Build the Route Coverage

Arc: shapearc lrs_rt_1099 lrsrt – create the coverage lrsrt from the shapefile.

Create the ArcInfo route system using the LRS identifier and appropriate route measurements.

Arc: arcsection lrsrt cntyl lrs_key beg_cnty_l end_cnty_l

lrsrt – LRS coverage
cntyl – the route system; this can be any name
lrs_key – LRS identifier
beg_cnty_l – LRS beginning route measure
end_cnty_l – LRS ending route measure

The beg_cnty_l and end_cnty_l measures were chosen arbitrarily for this example. There are other route measures evident in the road data that may be more appropriate for use. The table shows these measure fields.

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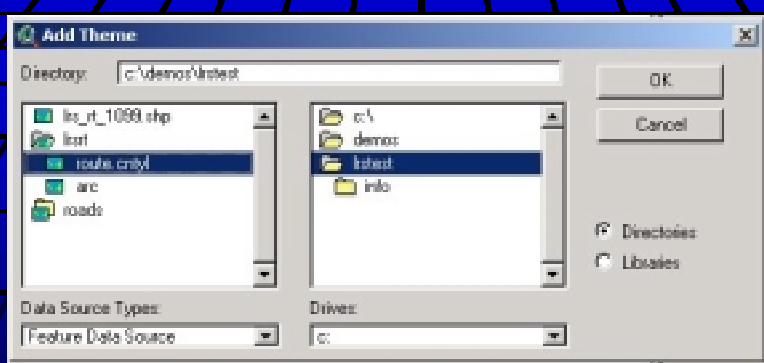
Add the Route Coverage in ArcView



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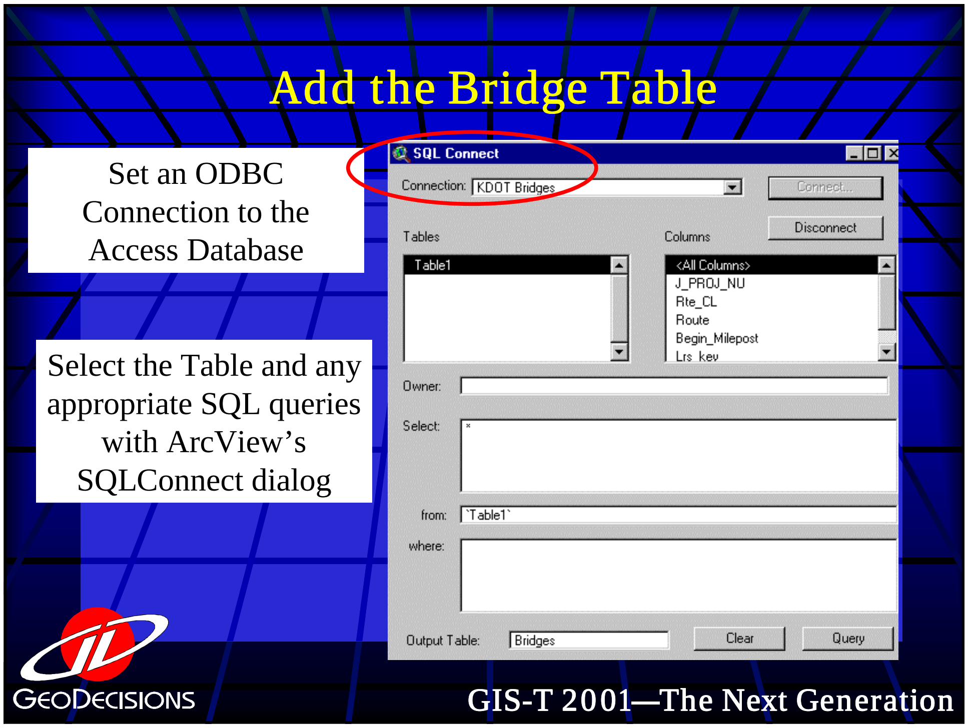
Add the Bridge Table
Set an ODBC Connection to the Access Database
Select the Table and any appropriate SQL queries with ArcView's SQLConnect dialog
SQL Connect
Connection: KDOT Bridges
Connect...
Disconnect
Tables
Columns
Table1
<All Columns>
J_PROJ_NU
Rte_CL
Route
Begin_Milepost
Lrs_key
Owner:
Select:
from:
`Table1`
where:
Output Table:
Bridges
Clear
Query
GeoDecisions
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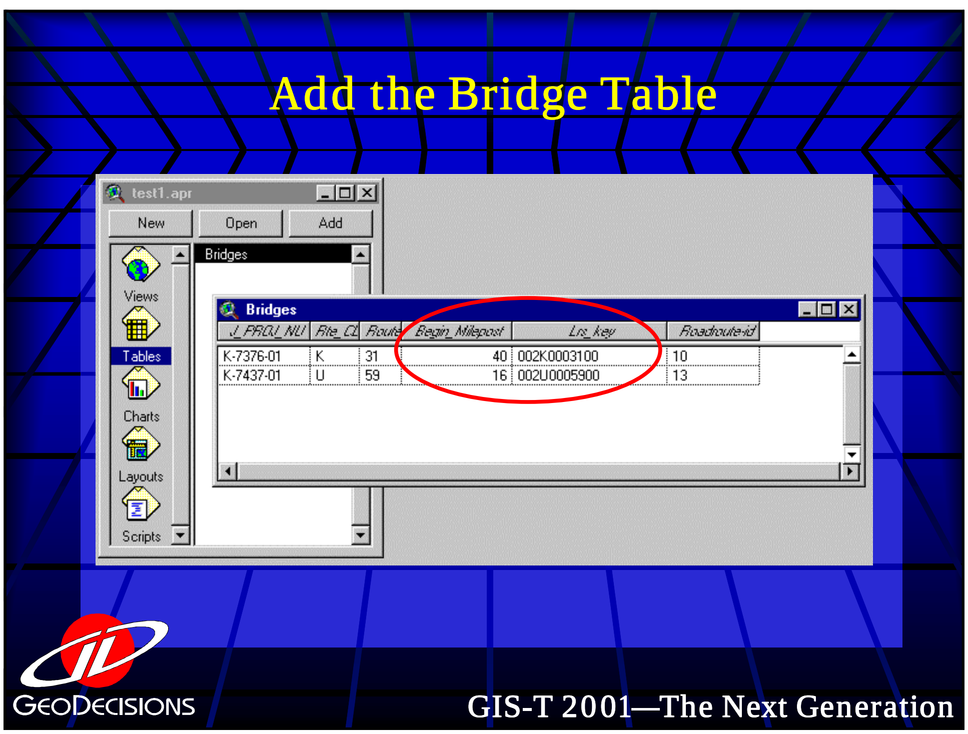
Add the Bridge Table
test1.apr
New
Open
Add
Views
Tables
Charts
Layouts
Scripts
Bridges
J_PROJ_NU
Rte_CL
Route
Begin_Milepost
Lrs_key
Roadroute-id
K-7376-01
K
31
40
002K0003100
10
K-7437-01
U
59
16
002U0005900
13
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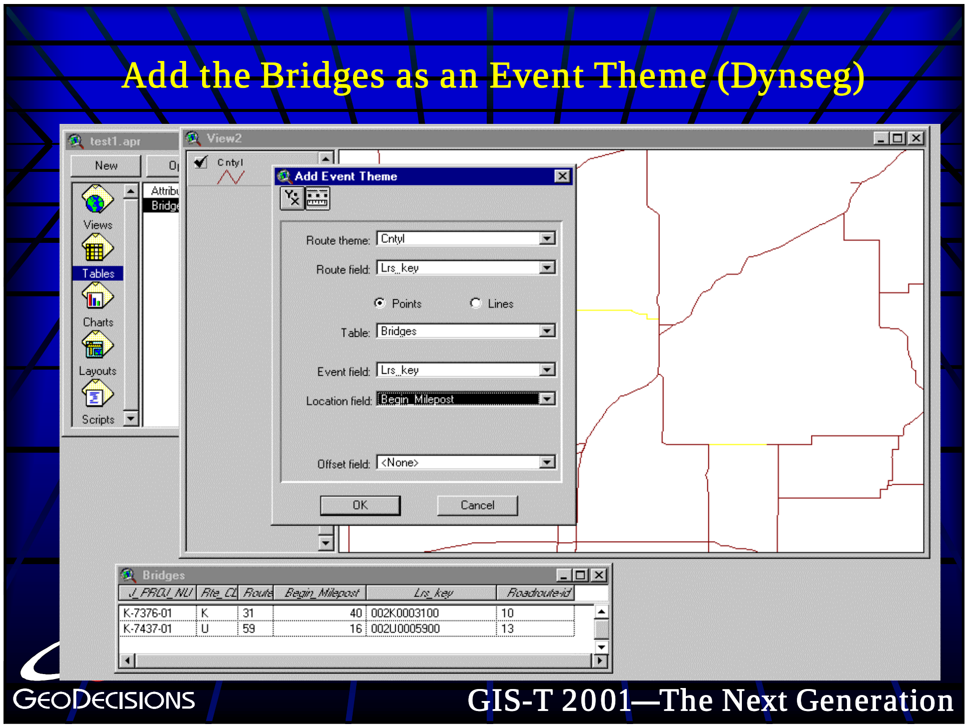
Add the Bridges as an Event Theme (Dynseg)
test1.apr
View2
Add Event Theme
Route theme: Cntyl
Route field: Lrs_key
Points
Lines
Table: Bridges
Event field: Lrs_key
Location field: Begin_Milepost
Offset field: <None>
OK
Cancel
Bridges
J_PROJ_NU Rte_CL Route Begin_Milepost Lrs_key Roadroute-id
K-7376-01 K 31 40 002K0003100 10
K-7437-01 U 59 16 002U0005900 13
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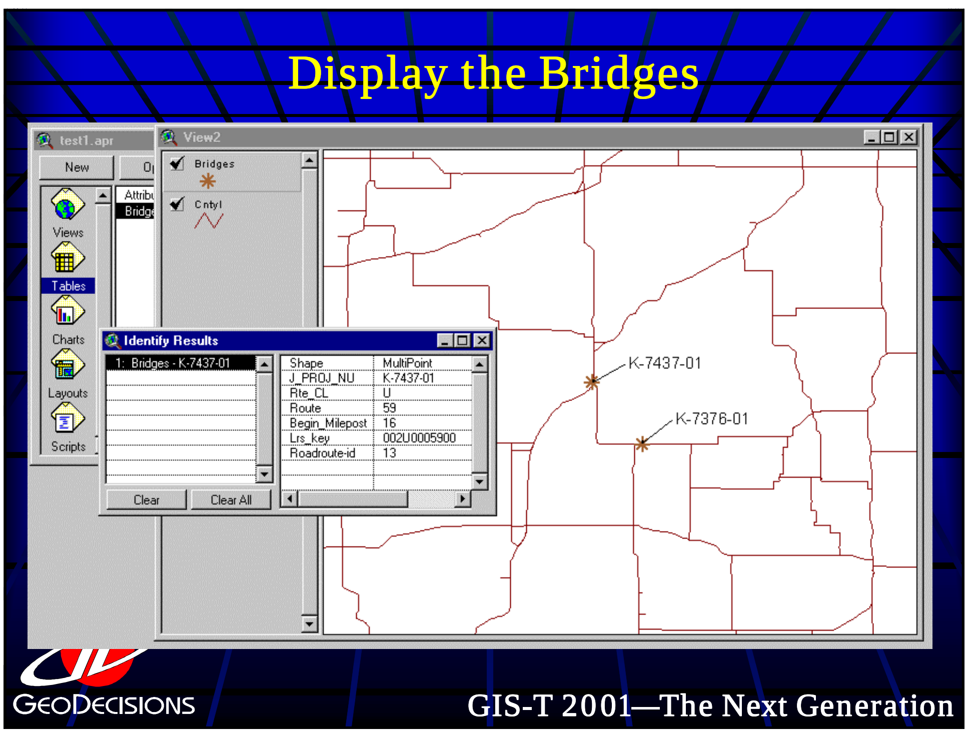
Display the Bridges
test1.apr
View2
Bridges
Cntyl
Identify Results
1: Bridges - K-7437-01
Shape MultiPoint
J_PROJ_NU K-7437-01
Rte_CL U
Route 59
Begin_Milepost 16
Lrs_key 002U0005900
Roadroute-id 13
Clear
Clear All
K-7437-01
K-7376-01
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Example - Complex

- Transportation Information System for MPOs, LDDs, and Counties in Pennsylvania
- Uses PennDOT LRS and event tables to allow local planners access to roadway information

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Example - Complex

- PennDOT uses Intergraph GIS products
  - MGE, GeoMedia
- Roadway, Bridge and Project Management Systems in Oracle
- GeoMedia is used to port data to ArcView
  - Shapefile of State Roads with NLF as attributes
  - Access database created from Oracle data

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Example - Complex

- Arc/Info is used to create a State Road route system based on NLF
  - Currently maintained as an Arc/Info coverage
- ODBC Driver to use the Access database
  - Series of SQL Connect scripts to use tables
- Data Exchange Procedures are Established
  - PennDOT supplies new data to MPO or RPO
  - Counties can provide data back to PennDOT
    - Road names, addresses

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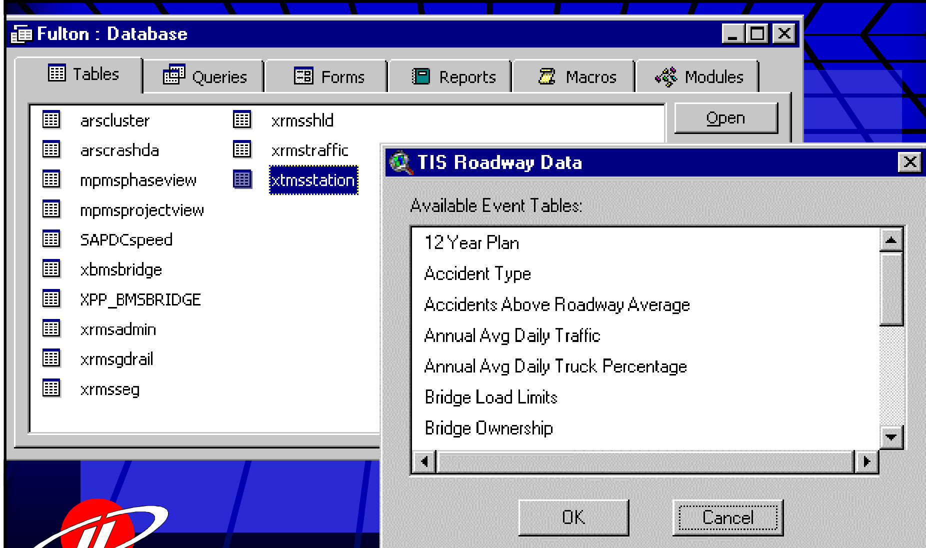
PennDOT Databases



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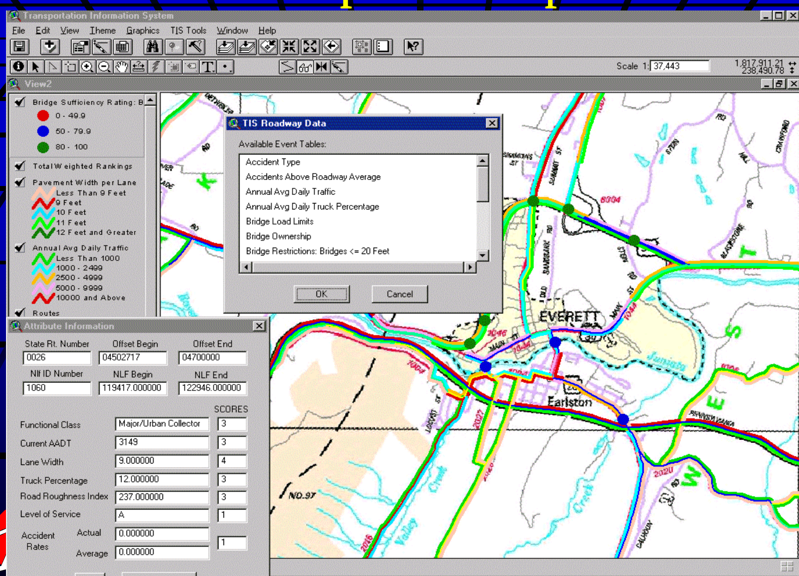
Example - Complex



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Information

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Spatial Solutions for Document and Information Management

David Kingsbury

GIS for Transportation – Business Development

Mapping and GIS Division - Intergraph Corporation

djkingsb@intergraph.com

GIST 2001 – April 11, 2001

Outline

Why Spatial Access to Data and Documents?

What examples of an SE-EDMS are there?

(What are other Transportation organizations doing?)

Recommended approach to a SE-EDMS

Why Spatial Access to Data and Documents?

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Users' demand for ***data access*** *is* ***high!***

- **Use a map to locate information**
  - Transportation orgs business interest cover large areas, spatial relationships often are the most efficient method to locate information.
- **Ease of access, intuitive, A map based interface allows for rapid location of information by less knowledgeable users.**
- **Data is available across the enterprise**
- **Technology is available**
  - Network technology allows connecting to the data
  - Database technology allows data sharing and integration
  - GIS technology should pose no data integration problems
  - EDMSs today are easier to manage
  - Integration between spatial features and digital documents is technologically simple (spatial referencing systems)

INTERGRAPH
Mapping and GIS Solutions

Spatial Referencing Systems – Methods Supported

GIST 2001 · VIRGINIA

Pick a point in the map

- **Spatial Co-ordinate values in a Mapping Projection or Latitude and Longitude**

Pick a feature on the map

- **Graphically Displayable Element**

Dynamically create a feature on the map

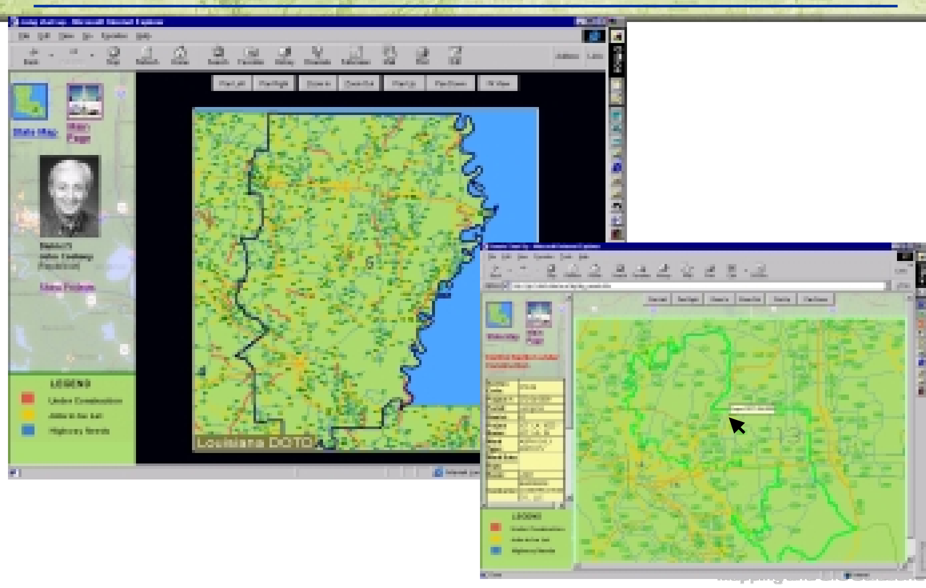
- **Linear Referencing System"Route" and "Milepost Range"**

INTERGRAPH
Mapping and GIS Solutions

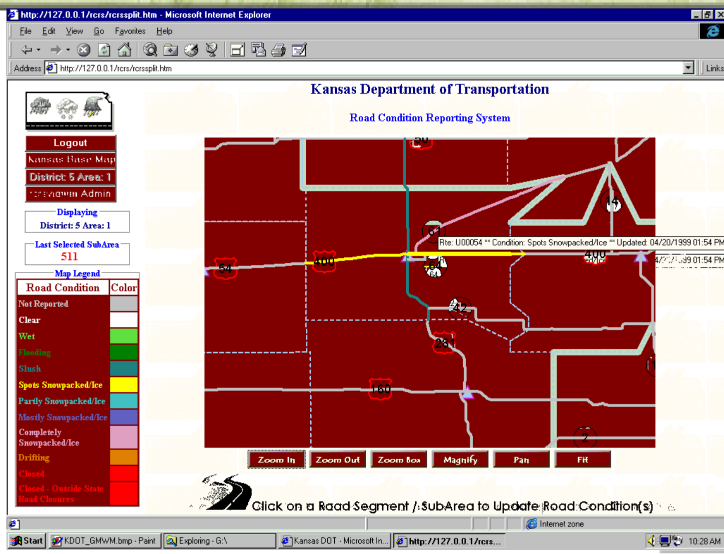
Examples of SE-EMDS
- Using Web Technology
- Available Desktop/Web Technology

Intergraph
Mapping and GIS Solutions

Project Information - Louisiana DOT

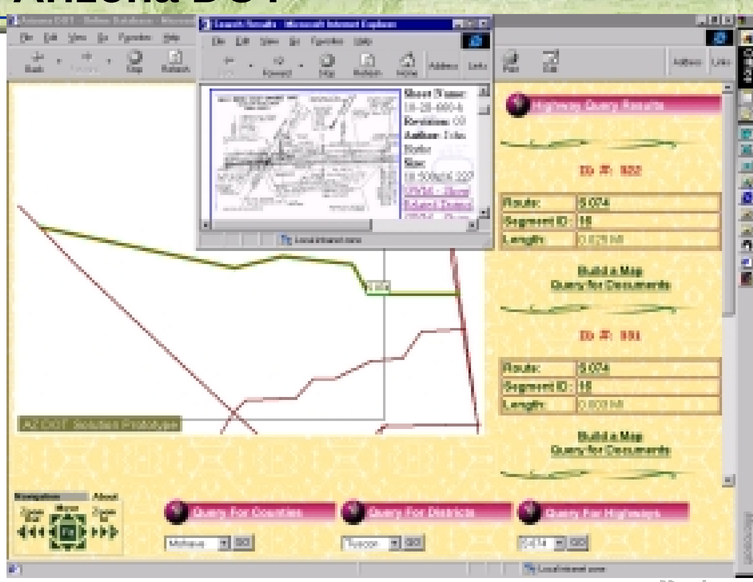


Road Conditions - Kansas DOT



Mapping and GIS Solutions

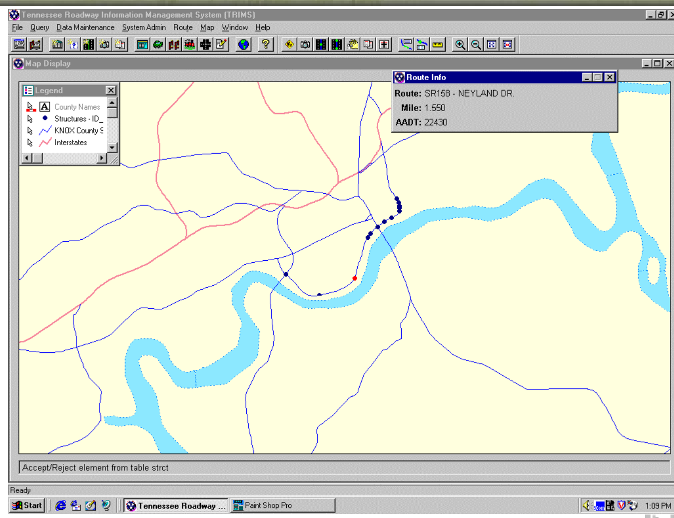
Drawing Access - Arizona DOT



Mapping and GIS Solutions

Asset Management
- Tennessee DOT TRIMS

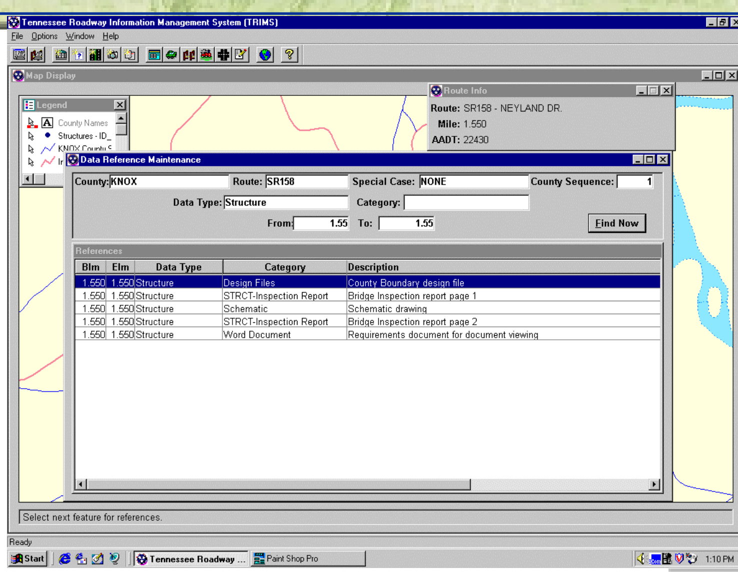
GIS/T 2001 VIRGINIA



INTERGRAPH
Mapping and GIS Solutions

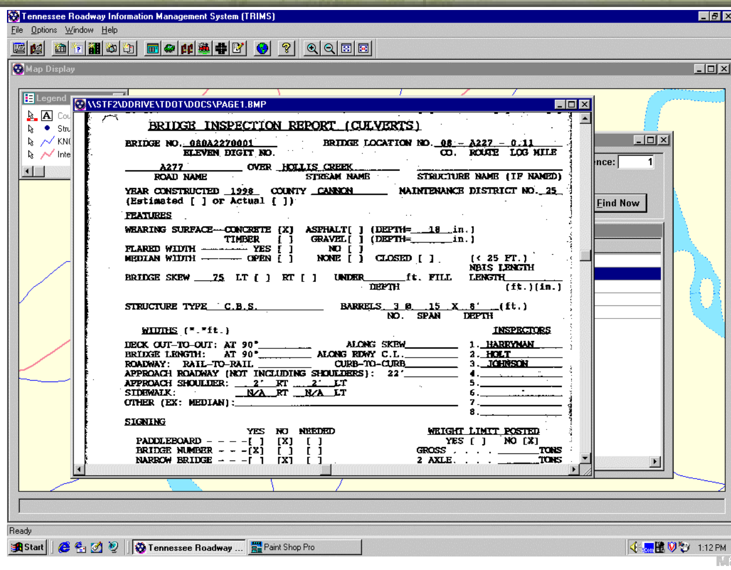
TRIMS
- Asset identification

GIS/T 2001 VIRGINIA



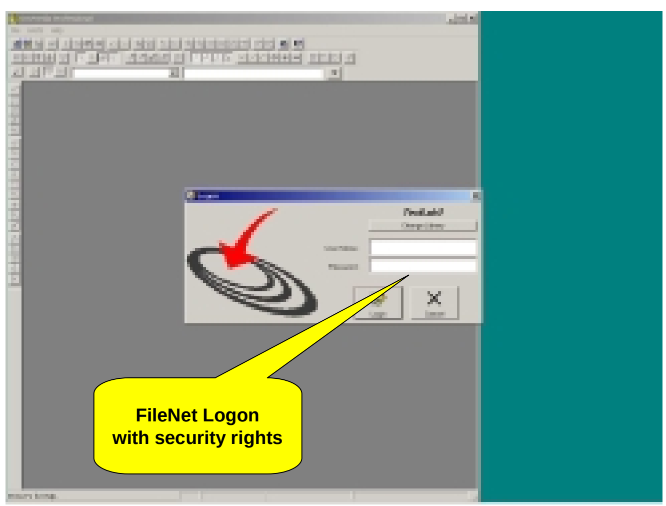
RGRAPH
Mapping and GIS Solutions

TRIMS
- Related Document Access



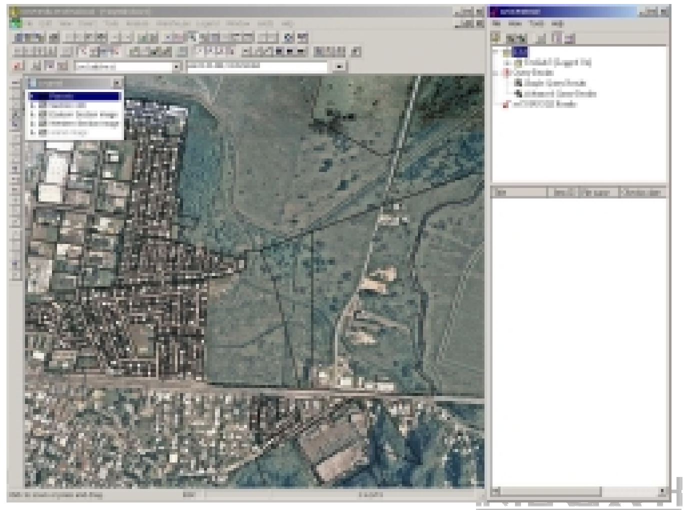
SE-EDMS
- "out of the box" Solution

The user selects **Logon** and must enter a valid User Name and Password as defined by the EDMS security system.



SE-EDMS
- GIS-EDMS Integration

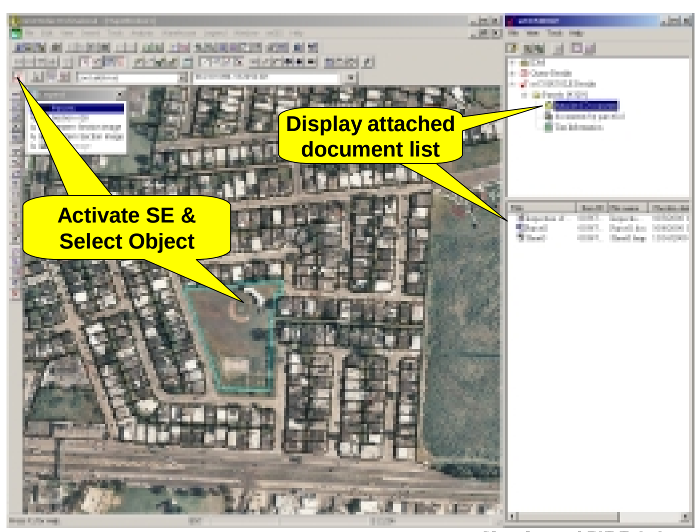
The GeoWorkspace is retrieved from FileNET and loaded into GeoMedia



Mapping and GIS Solutions

SE-EDMS
- Pick the feature –find related docs

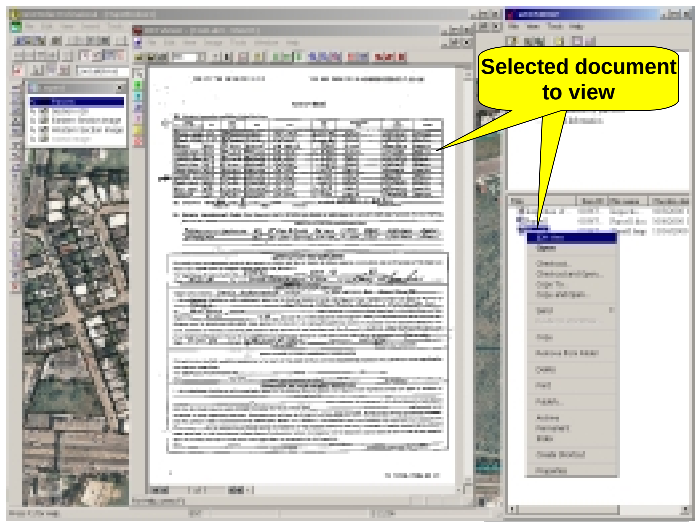
The user can activate the "sx Icon" from tool bar and then locate any spatial object in the map window. This enables all documents that are attached, to be displayed in the document list box.



Mapping and GIS Solutions

SE-EDMS
- Display the related Documents

If a user has the appropriate security rights, they can open or view the document



SE-EDMS
- Recommendations

- Create an internal project team to research an SE-EDMS
- Pin point several candidate implementations that would benefit the organization
  - **Must be "in line" with the Enterprise Wide Vision for Information Sharing**
- Choose a systems integrator that knows your business
- Use a phased approach - start small and ***viewing only***
  - **Choose a set of business processes, documents and data** to implement within an EDMS that can achieve measurable results in a single funding period
- Involve a small set of users – satisfy them first, then broaden
  - A system developed without user participation, will not be used and the system will fail.
- Develop and implement a Disaster Recovery Plan
- Internally promote the HECK out of the SUCCESSFUL system!

Summary

User Demand to access documents is HIGH!

- We are a document centric world!

Maps are intuitive everyone!

The technology is all available – today!

The integration of maps and documents provide a solution with mass appeal including:

• productivity gains

• and significant cost savings

Investigate a Spatially Enabled – EDMS TODAY!

Summary

Thanks to:

LA DOTD

Kansas DOT

Arizona DOT

Tennessee DOT

Intergraph Government Solutions Division
www.intergraph.com/govt

Spatiax, Inc – Spatial Enterprise Solution
www.spatiax.com

David Kingsbury

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www.intergraph.com/gis

Geo-Referenced Information Portal (GRIP)

John Van Vliet & Jared Lish
Xmarc, Inc.
April 11, 2001

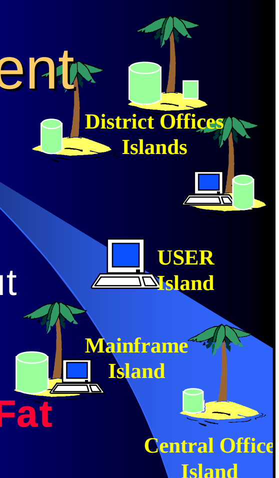
Agenda

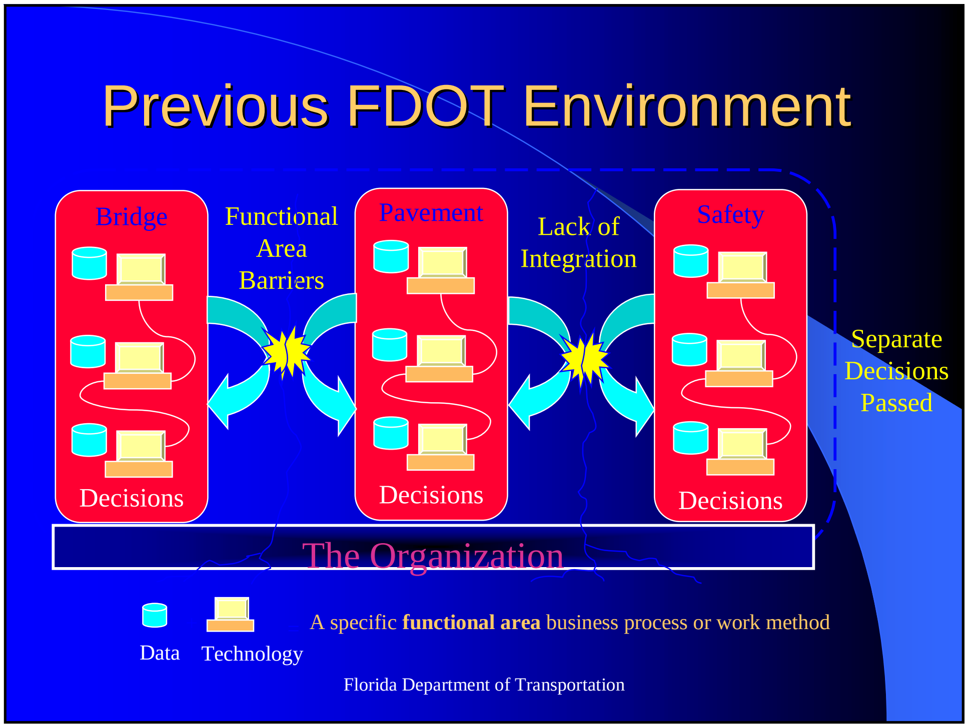
- Previous V.S. New GRIP Environment
- GRIP Business Drivers & Key Concepts
- Goals of the GRIP Solution
- GRIP Solution
- Ancillary Benefits
- FDOT GRIP Demonstration

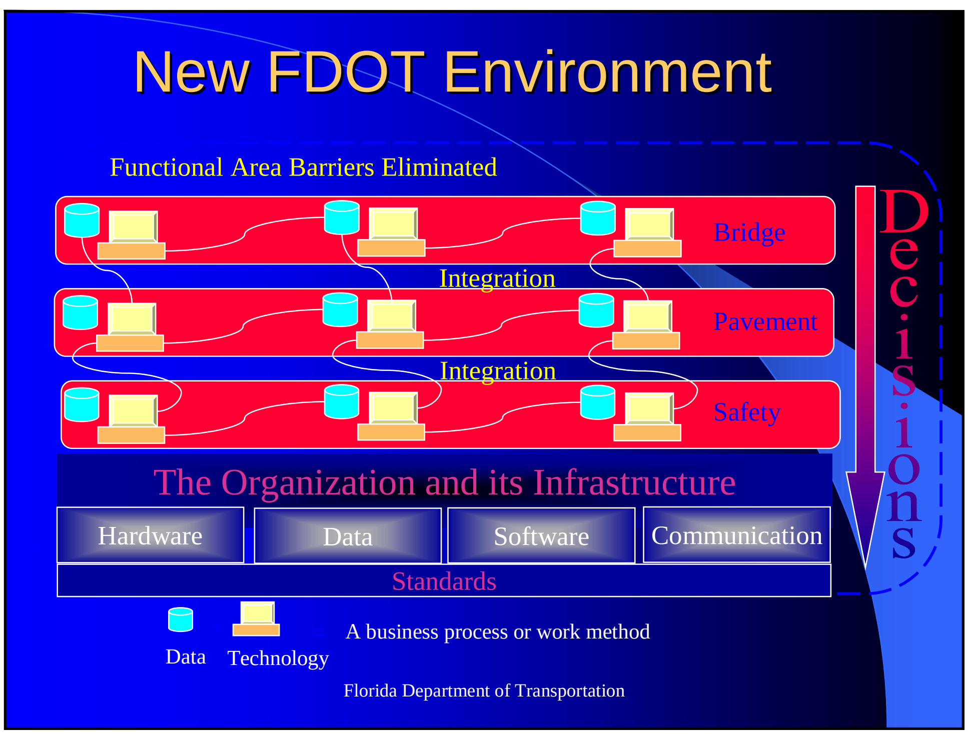
Previous vs. New GRIP FDOT Environment

Previous FDOT Environment

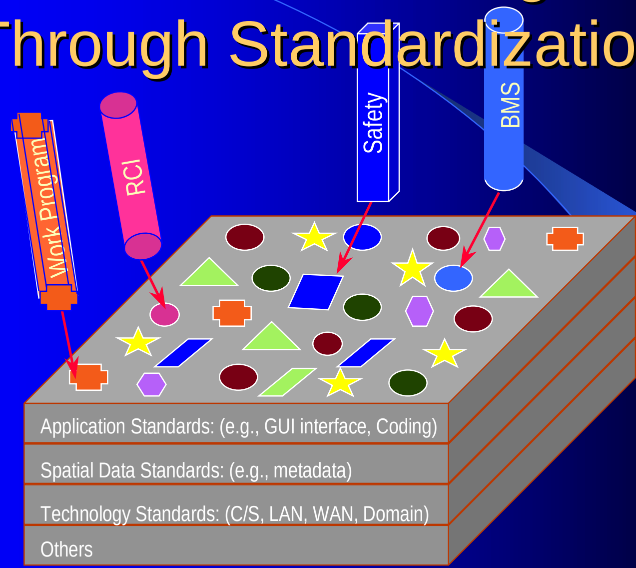
- Variety of Disparate Databases (mainframe, oracle, foxpro, etc.)
- Redundant copies of data throughout the functional areas and districts
  - Data integrity a serious issue
- Numerous Independent Islands of **"Fat Client"** applications
- Large Number of Users at various skill levels




Previous FDOT Environment
Bridge
Functional
Area
Barriers
Pavement
Lack of
Integration
Safety
Separate
Decisions
Passed
Decisions
Decisions
Decisions
The Organization
Data
Technology
A specific functional area business process or work method
Florida Department of Transportation


New FDOT Environment
Functional Area Barriers Eliminated
Bridge
Integration
Pavement
Integration
Safety
Decisions
The Organization and its Infrastructure
Hardware
Data
Software
Communication
Standards
Data
Technology
A business process or work method
Florida Department of Transportation

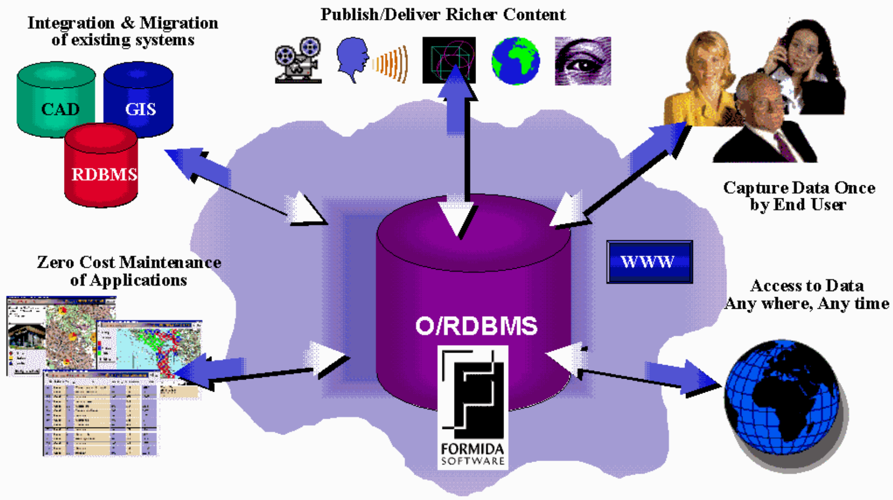
The Pieces come together Through Standardization



Florida Department of Transportation

Business Drivers & Key Concepts

Business Drivers



Key Concepts for the GRIP

- The Enterprise Information System **IS NOT intended** to **ELIMINATE or Replace** any existing applications.
- The GRIP **IS** focused toward **INTEGRATION, DISSEMINATION, and LEVERAGING** existing technologies and infrastructure
  - **Not making New Data**

Enterprise Information System
Key Integration Components

CAD

GIS

Database

Networking

Office Automation

Document Management

Web

Civil/Survey

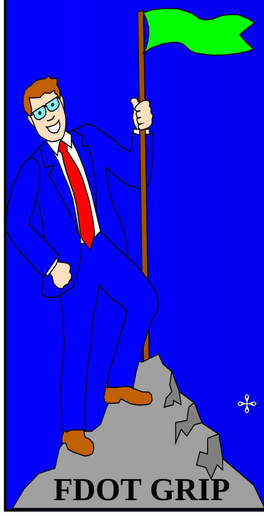
Aerial Photography

Florida Department of Transportation

Goals of the Enterprise Information System

Goals of the GRIP

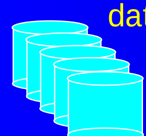
- Management of digital assets using a Data Centric Approach
  - ***promote a single, Enterprise data resource;*** (whether logical or physical)
  - encourage data sharing across functional and organizational boundaries;
  - increase confidence in the Department's digital geospatial data by maintaining ***data consistency*** and ***integrity***;
  - Handle temporal issues by providing all users with immediate and easy access to up-to-date information, and;
  - eliminate redundant collection and storage of information.
- Maintain State and Federal perspective



Need to Use Past Investments to Add Value in Meeting Today's Needs

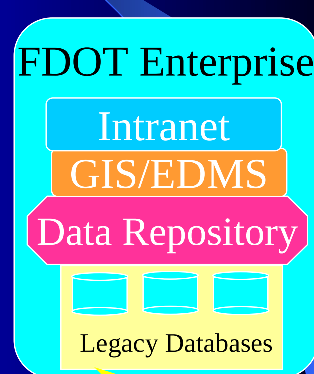
PAST

Enormous investments in organizational databases



CARS
Pavement
ROW
CAD
Bridge

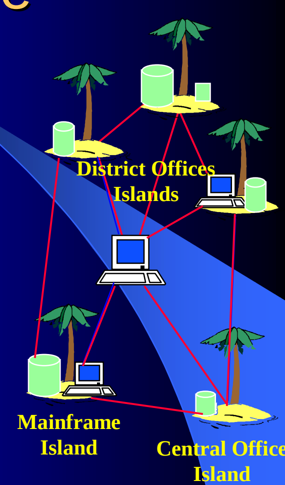
PRESENT



GRIP Solution

GRIP Architecture

- Consists of an integrated multi-layered GIS spatial database as well as attribute and image servers residing in each district
  - Access to each district repository is provided by trust agreements within and across district boundaries
- PCs connect to Server via the Intranet (Local Area Network (LAN))
- Each PC has an internet browser (to access the centralized database across the LAN)
- Multiple layers of functionality (i.e., power-users and casual users)



FDOT Business Requirement	FDOT GRIP
Integration, Dissemination, & Leverage	✔
Centralized access to the Department's business data	✔
Handle numerous data formats and types	✔
Increase timeliness and responsiveness	✔
Perform basic spatial analysis (visualization, queries, & reporting capabilities)	✔
Access to electronic documents (contracts, accidents, etc.)	✔
Consistent data reporting	✔
Provide access to the ALL Department users who have a PC and Intranet access	✔
User friendly interface	✔

Additional GRIP Features

Features	Benefits
Write Once Deploy Many	Decreased deployment $
Very thin Client	minimal resources
Version Control	Lower Maintenance costs
Centralized Management	Easy to configure, Increased Security Controls
Web Browser Based	Lower training costs and smaller learning curve = increased productivity
Scalability	Unlimited # of Users

Ancillary Benefits of GRIP

- Cost saving/avoidance
- Productivity gain
- Better decision support
- Provides a tool for improving quality control
- Reduction of application and data islands

Florida Department of Transportation

Geo-Referenced Information Portal

1. Build Upon and Enhance Existing Standards
   - GIS
   - Transportation Model
   - Base Map
2. Develop an Enterprise Information System Approach
3. Evolutionary Development Consisting of

Phase 1 - Creation of GRIP Vision, Functional and Data Requirements, Program Structure
- Develop Enterprise Base Map

Phase 2 - Rapid Application Development of GRIP Working Prototype with minimal functionality

Phase 3 - Integration of Priority Data Areas
- Integration of Transportation Model Data in GIS
- Database Design, Application Design & Refinement, and Technical Architecture

Phase 4 - Make GRIP accessible to all users via Intranet and Browser GUI
- Port all data into Oracle data repository

Phase 5 - Develop additional applications for different users sharing same database

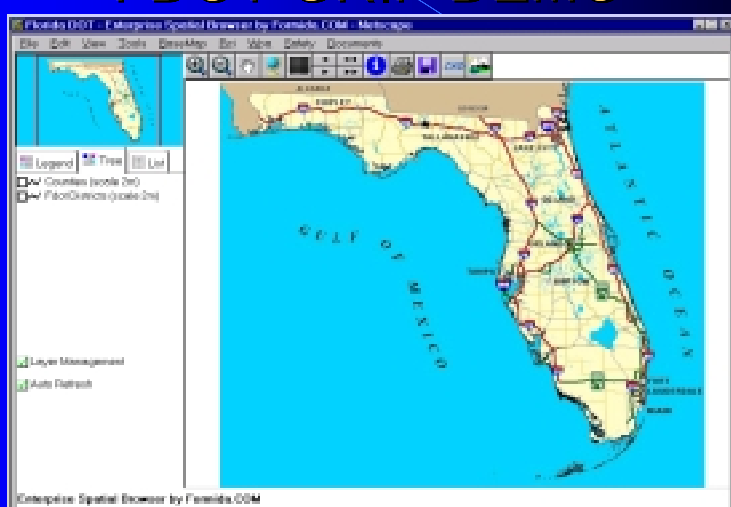
Phase 1 thru 4 running from September 1999 to December 2000.
Decision 5 yet to be taken.

Florida Department of Transportation

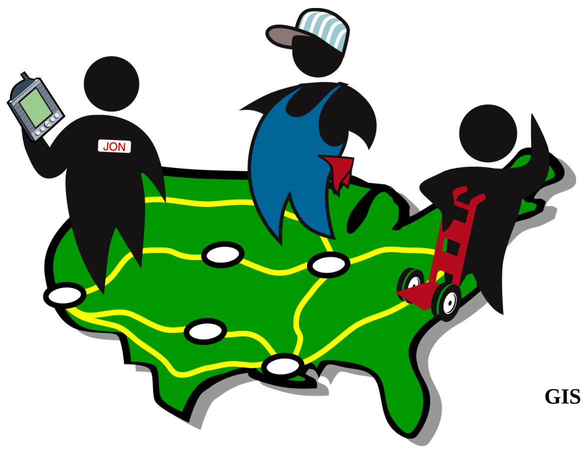
Contact Information

Ms. Mavis Georgalis
Manager of Specialized Technologies
Florida Department of Transportation
850-922-8928

FDOT GRIP DEMO



Implementing a Scalable GIS Solution
Into a Resource Management System



Michael Schonlau
GIS Software Engineer

Nexterna

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Presentation Overview

- Company Background
- Application Overview
- Evolving GIS Architecture
- Data issues
- Software Issues
- Development Environment
- Conclusion

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Who We Are

- **Founders (1987)**
  - Union Pacific
  - Alcatel Canada Telecommunications
  - Tandem Computers (Compaq)
- **Owners (1990)**
  - Union Pacific Corporation
- **15 Years Experience**
  - Wireless Data Communications
  - Location Services

Fēnix
Software, hardware, telecommunications infrastructure

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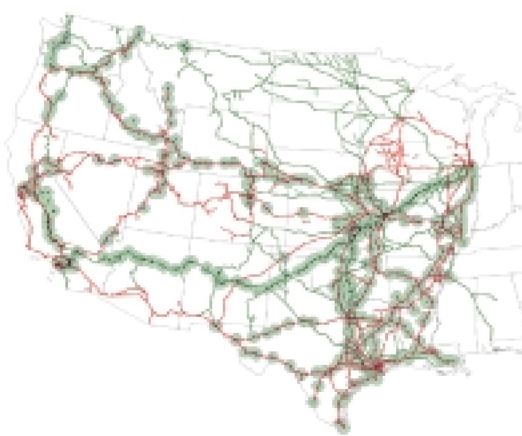
Nexterna's Accomplishments



- **Nexterna Built One of the Nation's Largest Packet Data Networks**
  - 23 States
  - 12,000 Miles
  - 500,000 Wireless Messages Each Day

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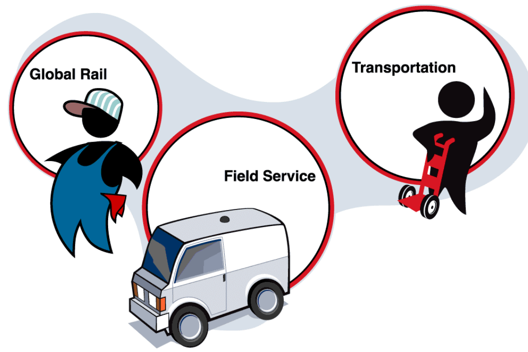
Business Highlights

- **Current Focus**
  - Global Rail
  - Transportation
  - Field Service



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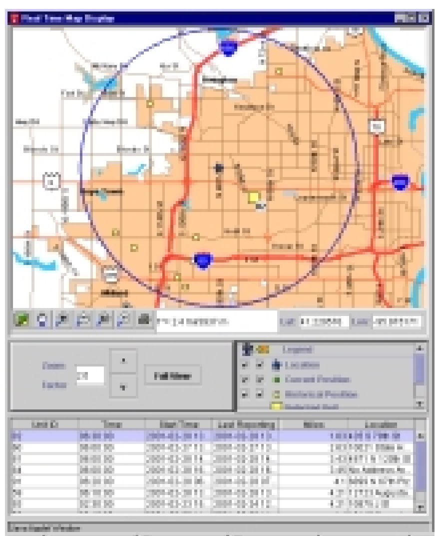
OptiTrac

- **Advanced Location Tracking System**
  - Track Vehicle Location
  - Query Vehicles on Command
  - Gather Location and Usage Data
  - Get Address-Level Detail on Each Vehicle
  - Locate the Nearest Vehicle to a Specific Address
  - Access Vehicle Data via the Internet



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Application Components

- **GPS Service**
  - Hardware
  - Wireless Middleware
  - Database
- **GIS Service**
  - Industry-Specific Spatial Data
  - Internet Mapping Software
- **Application Server**
  - Resource Manager/Client GUI

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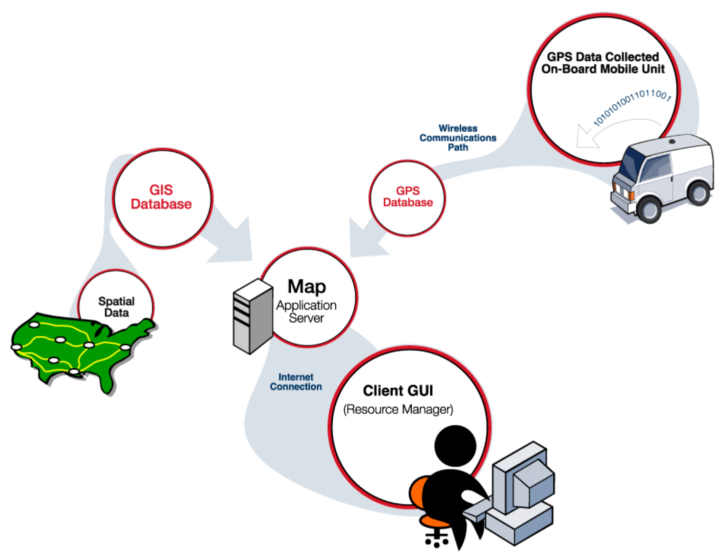
System Overview Diagram



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Initial Architecture

- **Simplistic Map Interface**
  - Only the Standard Zoom, Pan, Selection Tools
- **Railroad Maps**
  - Proprietary Customer Data
  - NTAD 2000 (Bureau of Transportation Statistics)
  - TIGER (Bureau of the Census)
- **Early IMS Software**
  - Map Objects IMS (1999)
  - ArcIMS Beta Program (1999-2000)
  - SpatialFX Suite From ObjectFX (Spring 2000)

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Our GIS “Evolution”

- **OptiTrac™ 2.0 Released 7/15/00**
  - **Simple Railroad Maps**
- **OptiTrac™ 2.1 Released 9/15/00**
- **OptiTrac™ 2.2 Released 12/15/00**
- **OptiTrac™ 3.0 Requirements Document 10/15/00**
  - 90-120 day implementation
  - “New” GIS
- **OptiTrac™ 3.0 released 2/15/01**
- **God Bless Sales & Marketing!!**

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New Product Requirements

- **Current Spatial Data**
  - Within One Year
  - Custom Requests for New Construction Areas
- **Accurate Spatial Data**
  - Minimum 95% Address-Matching
  - Comprehensive Attributes
    - Geocoding
    - Unit Detail Window
- **Additional Map Functionality**
  - Geocoding
  - Reverse-Geocoding
  - Spatial Queries (Nearest Unit)

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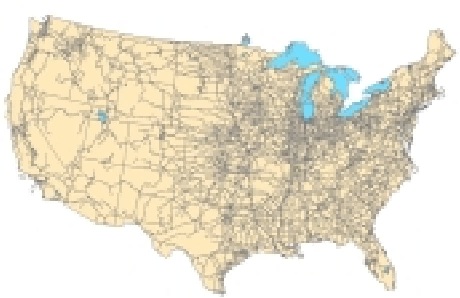
Data - Rail Industry

- **Many Customer-Supplied Datasets**
- **Attribute Data Most Important**
- **Government Data Meets Requirements**



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Data - Transportation Industry

- Comprehensive Interstate/Highway Networks
- TIGER streets
- Government Data Meets Requirements
- Future May Include Geocoding

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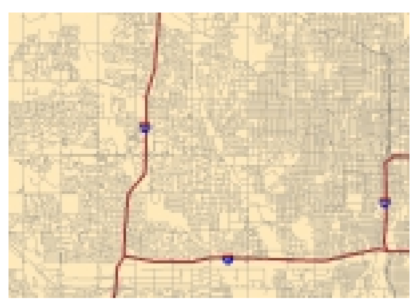
Data - Field Service Industry

- Highly-Detailed Street Data
- Geocoding Attributes
- Government Data not Sufficient
- Commercial Vendors: GDT, Etak, Navtech



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Data Vendor Evaluation

- **Technical Feasibility**
  - Nationwide Coverage
  - Plans to Add Canada & Mexico
  - Data Formats
- **Data Updates**
  - Update Availability and Schedule
  - Update Request Mechanism
- **Final Selection: GDT**

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Internet Mapping Software

- **Enhanced Functionality**
  - Geocoding Engine
    - Address-Level Detail
  - Reverse Geocoding Engine
  - Spatial Queries
    - Nearest Unit to a Point
- **Vendor/Product Research**
  - Products Compared with ObjectFX
  - ESRI, MapInfo, Autodesk, XMarc, Maptuit, Delorme
  - Product Matrix

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Software Product Evaluations

- **Technical Feasibility**
  - JAVA
  - Supported Data Formats
  - SDK/Custom Development Tools
  - Scope of Development Effort
- **“Open” Architecture**
  - Add-On Components (Routing, User-Editing, etc.)
  - Spatially-Enabled Database Support
- **Pricing**
  - Can’t Avoid the “Pay As You Grow” ASP Model
- **Final Decision: Go with What You Know**

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Internal GIS Efforts

- **“Back-End” Mapping**
  - ESRI Software (Arcview & Arcinfo)
- **Web “Optimization”**
- **Data Conversion**
- **Projections**
- **Cartographic Issues**
  - Legible Labels
  - Web Safe Colors
  - Consistent Symbology

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Development Environment

- **Server-side**
  - OptiTrac™ Application Components (Java)
  - GPS Database (Oracle)
    - UNIX-based C++ App Populates the Database (Converting to Java)
  - Application Server Software (WebLogic)
- **Client-side (Thin)**
  - Web Browser
    - Internet Explorer
    - Netscape Navigator
  - Java Plug-In

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Personnel

- **1 GIS Engineer**
- **2 Java Developers**
- **Supporting Staff**
  - Oracle DBA
  - Development Manager
  - Product Manager
  - Internet/Infrastructure Manager
  - OptiTrac™ Java Developers

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Hardware

- **Existing Application Server**
  - Stores Application Software, Mapping Software, and Spatial Data
  - Hewlett-Packard NT Server
    - Dual 600 MHz Xeon Processors
    - 1024 MB RAM
    - 30 GB Hard Drive
  - Recently Upgraded
- **Network Configurations**
  - Internet Bandwidth Issues
  - Firewalls
  - Proxy Restrictions
  - Slow Client PC's
  - Java Overhead

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Hardware

- **Internal Resources**
  - GIS Engineer PC
    - Pentium III
    - 800 MHz Processor
    - 512 MB RAM
    - 30 GB Hard Drive

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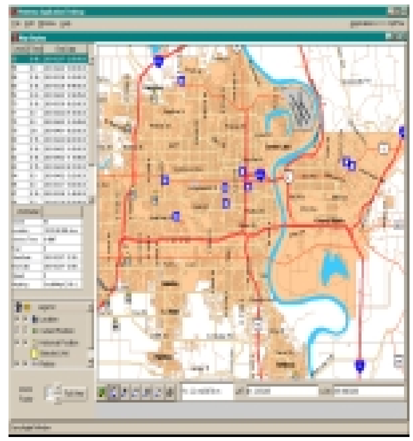
Conclusion

- "On-the-Fly" Implementation
- Scalable, Robust Mapping Application
- Dynamic Technology
- Countless Potential Wireless/GIS Applications in Transportation



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Thank You

- Questions
- Contact Info:

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Identification of Access Elements for Safety Analysis Using Aerial Photography

Srinivasa R. Veeramallu

Dr. Reginald Souleyrette and

Dr. Shauna Hallmark

IOWA STATE UNIVERSITY

GIS-T

April 11th 2001

CTRE

Center for Transportation Research and Education

USDOT Remote Sensing Initiative

- NCRST – Infrastructure
  - University of California, Santa Barbara (Lead), University of Wisconsin, University of Florida, Iowa State University
- Sponsored by
  - USDOT, RSPA
- In cooperation with NASA
- Matching funds, Iowa DOT

Introduction

- One person dies every 13 minutes (all crashes)
- Economic Cost
  - ➢Crashes in US - $150.5 billion/year (1994)
  - ➢Congestion – $72 billion/year (For 68 major Metropolitan areas in U.S.A)
- One cause: poor management of access

Source: BTS,TTI

Objectives

- Enable the increased application of access management using remote sensing to …
  - ➢Reduce cost of site specific access studies
  - ➢Facilitate cost effective systematic ID of problem areas
- See if RS data can be used in crash prediction models

Access Management

"… provide access to land development while simultaneously preserving the flow of traffic on the surrounding road system in terms of safety, capacity, and speed".

(Source: Federal Highway Administration, United States Department of Transportation)

Remote sensing

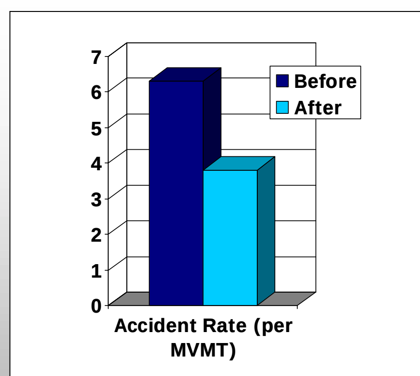
- "the use of electromagnetic radiation sensors to record images of the environment, which can be interpreted to yield useful information"
- Types of remote sensing
  - Satellite imagery
  - Aerial photography

What are the Benefits of Managing Access?

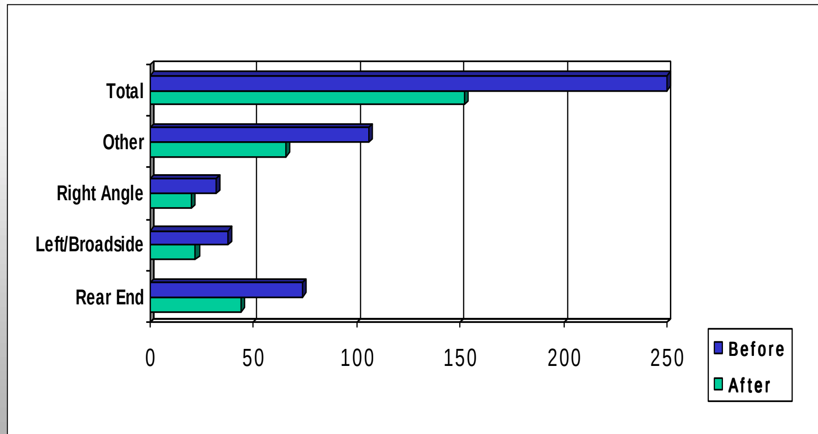
- Improved safety to motorists
  - Reduction in crashes and crash rates
- Improved traffic operations
  - Increased traffic level of service, capacity, and travel speed
- Safety and operational benefits for pedestrians, bicyclists, and public transit buses
- Lower overall costs for taxpayers
- Improved air quality

Safety Benefits: Iowa Case Studies

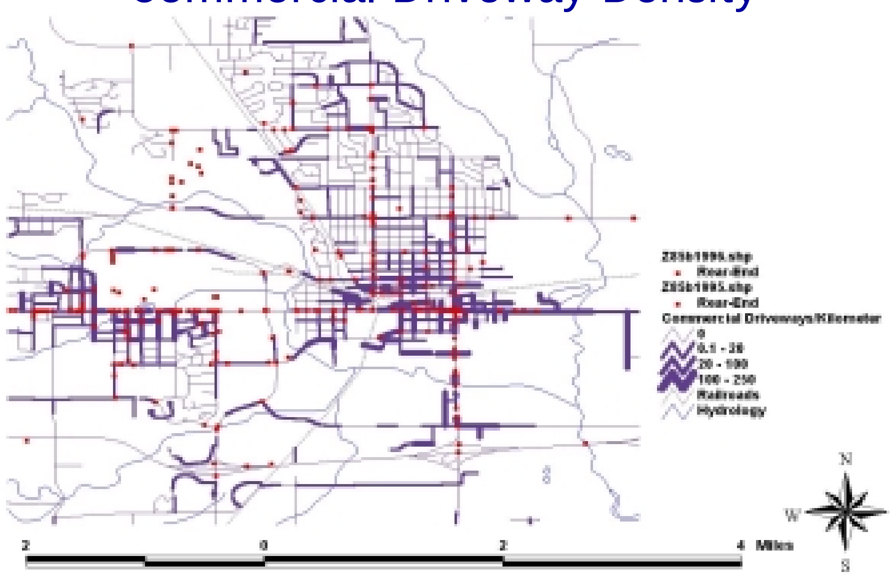
- Seven Iowa case studies were made on a "before and after" basis
- Case studies show nearly a 40 percent average reduction in accident rates after projects incorporating access management treatments were completed



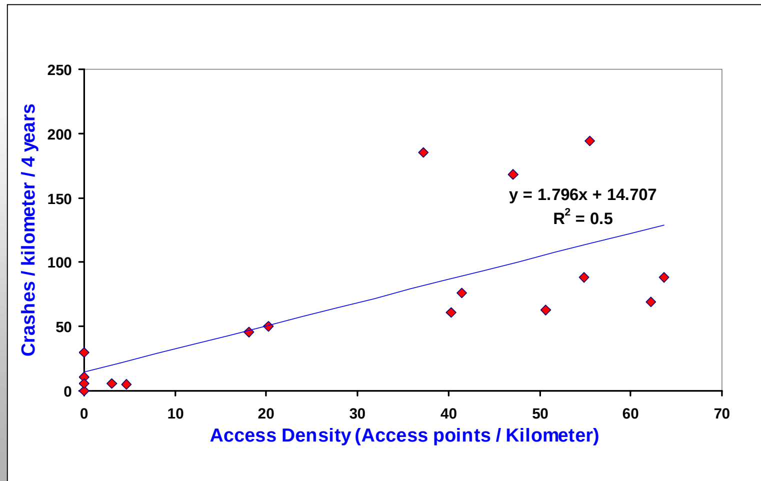
Safety Benefits: Crash Reduction By Type For Iowa Case Studies



Rear-end Crashes and Commercial Driveway Density



Mid-Block Crash Density vs. Access Control (Driveway Density)



Access Related Crashes

- Colorado 52%
- Oklahoma 57%
- Michigan 55%

Source: ITE

Research Problem

- Access studies typically done only on case by case basis
- Why? data collection is
  - time consuming
  - resource intensive
- Therefore ... no easy way to systematically ID priority areas for improvement

Research Approach

- Survey DOTs
- Identify data required for crash prediction models
- Collect data (and assess) by remote sensing
- Run models
- Identify priority areas for improvement of access control
- Comment on utility of entire process

Survey of State DOTs

- 10 state DOTs (8 responded)
  - Florida
  - South Dakota
  - Michigan
  - Oregon
  - Kansas
  - Wisconsin
  - Colorado
  - Minnesota
- Questions
  - ➢ Access management data elements collected
  - ➢ Method of collecting data

Survey of State DOTs

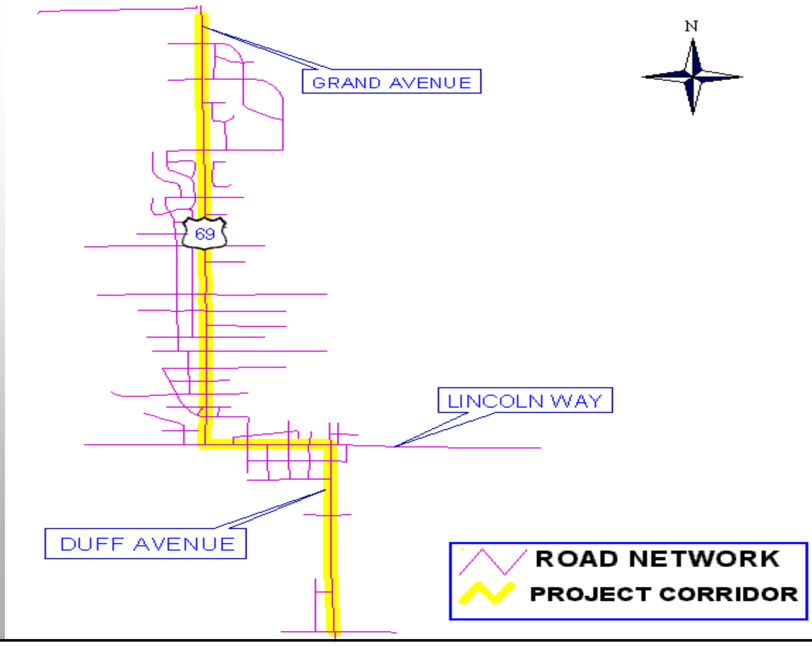
- None maintain a comprehensive database of access related data elements
- Usually collect data as needed (corridor level)
- Several
  - ➢ are in the process of developing one or
  - ➢ have indicated an inclination towards maintaining one.

DOT	Data collection methods	Comments
Florida	Video logging and surveying	Driveway locations are collected if part of an improvement project or permit.
Kansas	GPS receivers	The access database is being developed. KDOT is investigating the option of utilizing aerial imagery for data validation and display.
South Dakota	Plan sheets from construction projects	Aerial photography is used extensively during planning and project development, but not as a data collection tool for access management.
Wisconsin	Photo logs and from driveway permits	Aerial photography is only used for route layout and design, but not as a data collection tool for access management.
Michigan	Video logs	Does not maintain information related to access on an annual basis.
Colorado	Video logs	**Aerial imagery is used to identify access locations and circulation alternatives.**
Oregon	Video logs and Manual Data collection	Aerial photography and satellite imagery are used for spatial data collection.
Minnesota	Field inventory, Video logs and from as built records	The methods mentioned are project specific. Currently there is no existing system to record access permits.

Identify data required for crash prediction models

- Select statistical access management/crash model
  - Other research organizations
  - Crash frequency are f(#commercial driveways, median type, etc.)
- 17 study segments
  - US 69 corridor in the city of Ames, IA

Project Corridor



Data required

- Identify access-management related features required by crash models
- Model Form:

$$E(\wedge) = a_1 \times L^{a_2} \times V^{a_3} \times e^{\sum_{i=1}^{n} b_i x_i}$$

where

$E(\wedge)$ = predicted accident frequency

L = segment length

V = annual average daily traffic (AADT)

x_i = additional variables in the models

$a_1, a_2 . a_3, b_i$ are model parameters

Access Related Data Elements

- Driveways
  - Number
  - Dimensions
  - Spacing
  - Land Use
  - Continuity
  - Vertical grade
- Access roads
  - Presence
  - Configuration
- Medians
  - Presence
  - Type
  - Length
- Turn lanes
  - Length
  - presence
- Intersections
  - Type
  - Frequency
  - Proximity

Use of Remote Sensing

- Extract access-management related elements
  - Evaluate aerial photographs at different resolutions
  - Make recommendations on level required

Data

- Aerial Images
  - 6-inch pixel, panchromatic (Iowa DOT)
  - 2-foot pixel, panchromatic (Story county engineer's office)
  - 1 meter
- Crash Data
  - Iowa Department of Transportation
- Attributed Road network
  - AADT
  - Speed Limit

Data Extraction

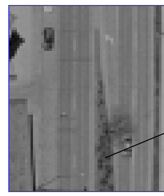
Commercial Driveway

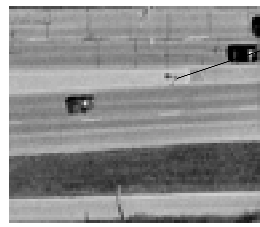
Residential Driveway

TWTL

Identifying Medians

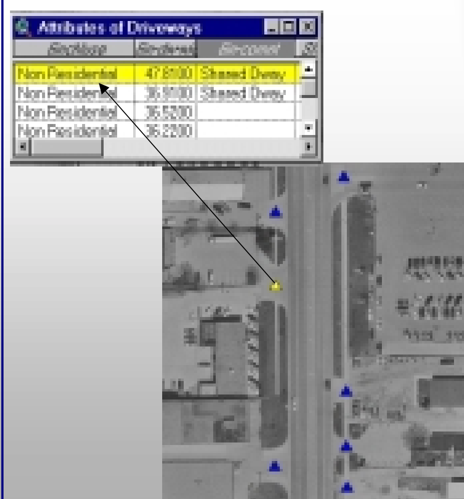
- Look for object markers along the center of the Road.
- Object markers are an important source of identifying the type and length of raised medians
- Pavement markings
- Depressed medians can be identified with ease as most of them are covered with Vegetation





Identifying Driveways

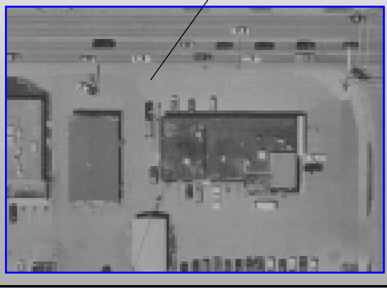
- Sharp difference in shade from the surrounding area
- Cuts along the curb
- Vehicular movement captured at the time of taking the photograph and parked vehicles may also be used as a source to identify driveway entrances
- Problems
  - ➢ Tree Cover (Dense Vegetation)
  - ➢ Several close driveways appear as one



Results

- 2 feet and 1 meter images
  - > 20% error rate)
- 6 inch resolution images
  - < 3% error rate)

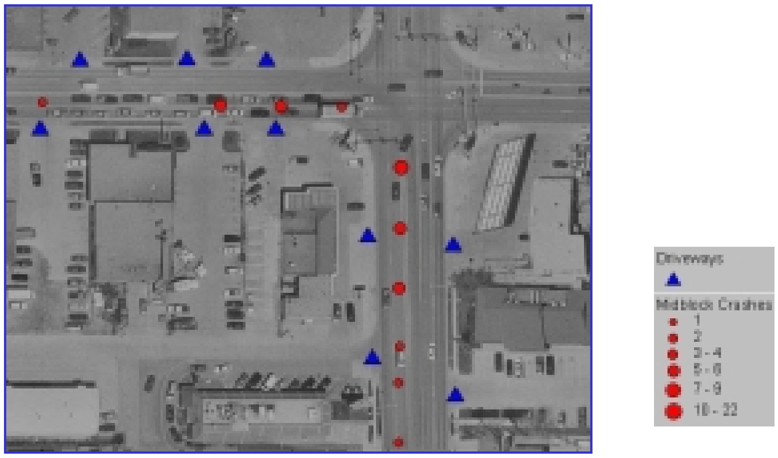
Where is the driveway?



Measurement Accuracy

- 31 Driveway Widths Measured
- 6 inch Panchromatic Aerial Orthophotos
- Field measurement is “truth”
- Mean error ~9 inches
- Standard error ~ 1 inch

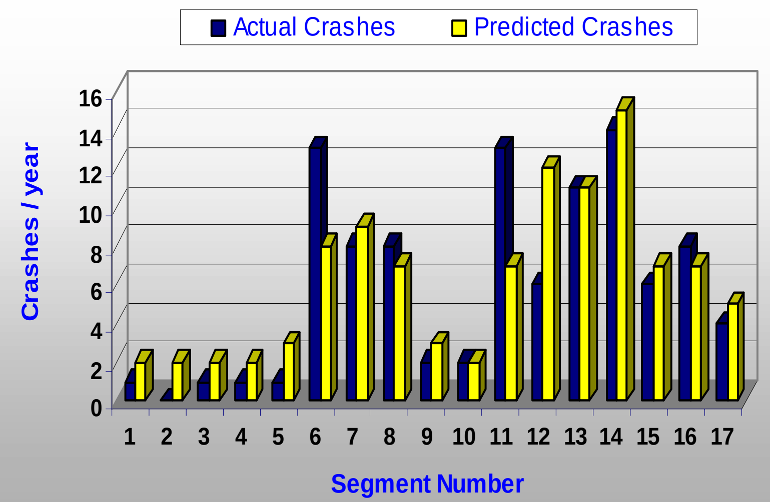
Safety Analysis



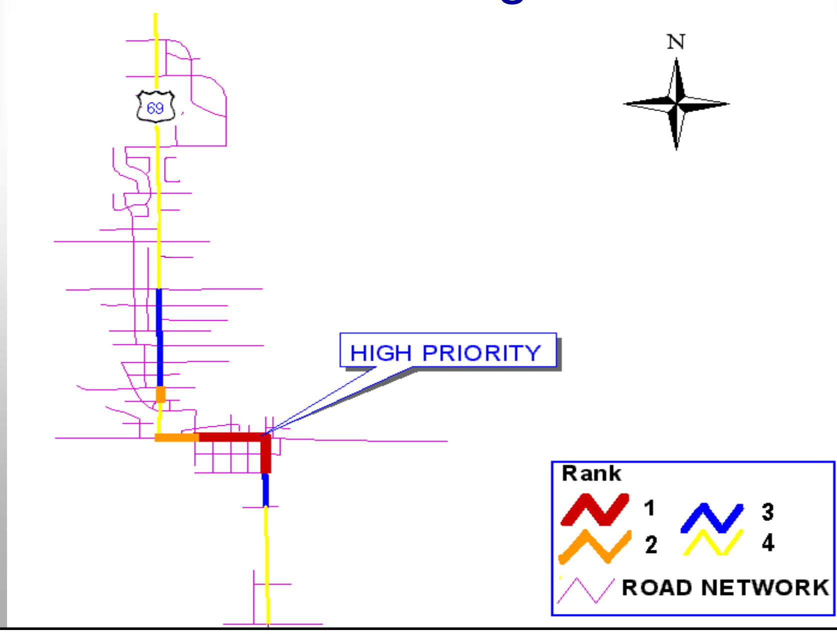
Safety Analysis

- Run models with RS data
- Compare outputs to known crash frequency
- Choose best performing model, adjust parameters for best fit
- Use model to forecast crashes
- Prioritize segments for improvement

Predicted Vs Actual Crashes



Prioritized Segments



Conclusions (so far)

- For all models tested …
- Remotely sensed data produce same result (rank) as field collected data
- Costs … field 10 hours, ortho's 5 hours, perhaps could be improved (scale, automation)
- 6” ortho’s are expensive but have multiple uses (not justified by this app. alone.)
- More work needed to extrapolate to systematic cost (and benefit!)

Not tested (next steps?)

- Are models “good enough” for systematic assessment?
- Can a qualitative “look” at photos (perhaps lower resolution) provide similar results at much lower cost?

Questions/Suggestions?

Roadway Intersection Inventory and Remote Sensing

David Veneziano
Dr. Shauna Hallmark and
Dr. Reginald Souleyrette

GIS-T 2001

April 11, 2001

USDOT Remote Sensing Initiative

- NCRST-Infrastructure
  University of California, Santa Barbara (lead), University of Wisconsin, University of Florida, Iowa State University
- Sponsored by
  - USDOT
  - RSPA
- NASA
- Joint endeavor with Iowa DOT

The Problem/Opportunity

- DOT use of spatial data
  - Planning
  - Infrastructure Management
  - Traffic engineering
  - Safety, many others
- Inventory of large systems costly
  - e.g., 110,000 miles of road in Iowa

The Problem/Opportunity

- Current Inventory Collection Methods
  - Labor intensive
  - Time consuming
  - Disruptive
  - Dangerous

The Problem/Opportunity

- Collect transportation inventories through remote sensing
- Improve existing procedures
- Exploit new technologies
- Extract data which was previously difficult and costly to obtain

Remote Sensing

- "the science of deriving information about an object from measurements made at a distance from the object without making actual contact” Campbell, J. *Introduction to Remote Sensing, Second Edition*.
- Three types
  - 1) space based or satellite
  - 2) airplane based or aerial
  - 3) in-situ or video/magnetic

Research Objective

- Can remote sensing be used to collect infrastructure inventory elements?
- What accuracy is possible/necessary?

Research Approach

- Identify common inventory features
- Identify existing data collection methods
- Use aerial photos to extract inventory features
- Performance measures
- Define resolution requirements
- Recommendations

Identify Common Inventory Features

- HPMS requirements
- Additional elements (Iowa DOT)

- Number of signals at intersections
- Number of stop signs at intersections
- Type of area road passes through (residential, commercial, etc)
- Number of business entrances
- Number of private entrances
- Railroad crossings
- Intersection through width

Required HPMS Features

- Section Length
- Number of Through Lanes
- Surface/Pavement Type
- Lane Width
- Access Control
- Median Type
- Median Width
- Peak Parking
- Shoulder Type
- Shoulder Width
  - Right and Left
- Number of Right/Left Turn Lanes
- Number of Signalized Intersections
- Number of Stop Intersections
- Number of Other Intersections

Inventory Features Collected

- Thru Lane Characteristics
  - Number, width
- Turning Lane Characteristics
  - Presence, type, number, **width, length**
- Shoulder Characteristics
  - Presence, width
- Parking
  - **type**
- Medians
  - Presence, type, width

- Access Features
  - Number, business, private
- Pavement type
- **Signal Structure/Type**
  - **Mast, post, strung**
- **Intersection Location**
  - **Commercial, residential, etc.**
- **Pavement Markings**
  - **Crosswalks, stop bars, pedestrian islands**

Data Collection Methods

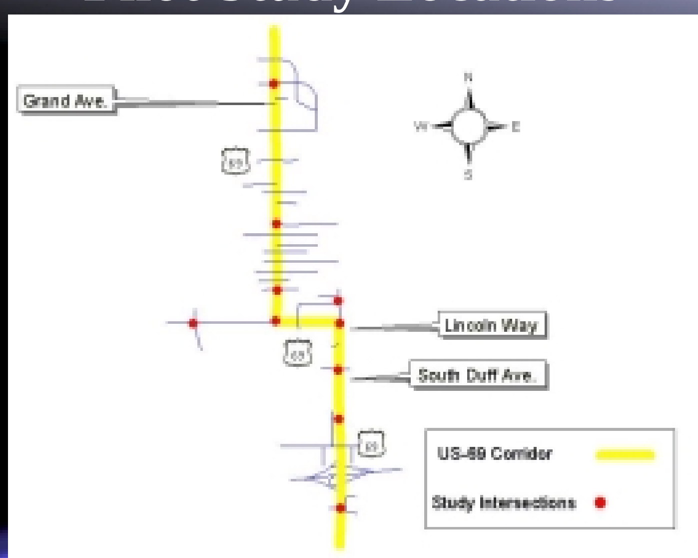
- Field data collection
  - GPS
  - Traditional surveying
  - Manual
- Video-log van

Datasets

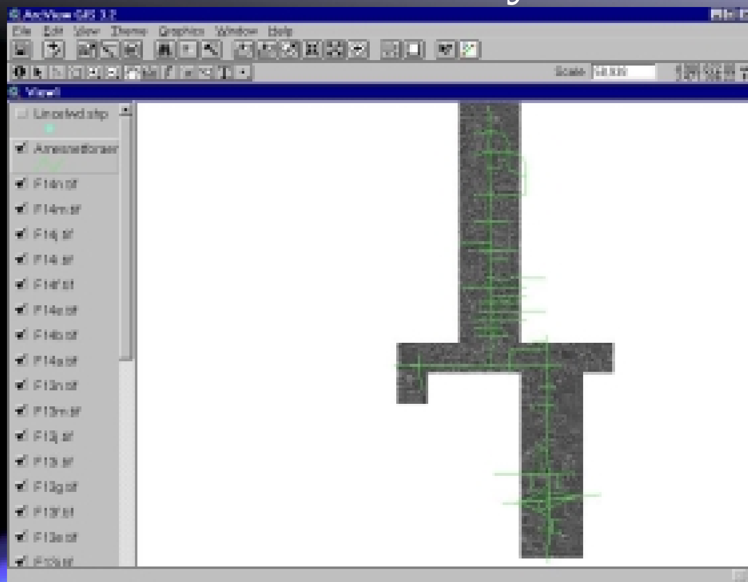
- 2-inch dataset - Georeferenced
- 6-inch dataset - Orthorectified
- 2-foot dataset – Orthorectified
- 1-meter dataset – Orthorectified

* not collected concurrently

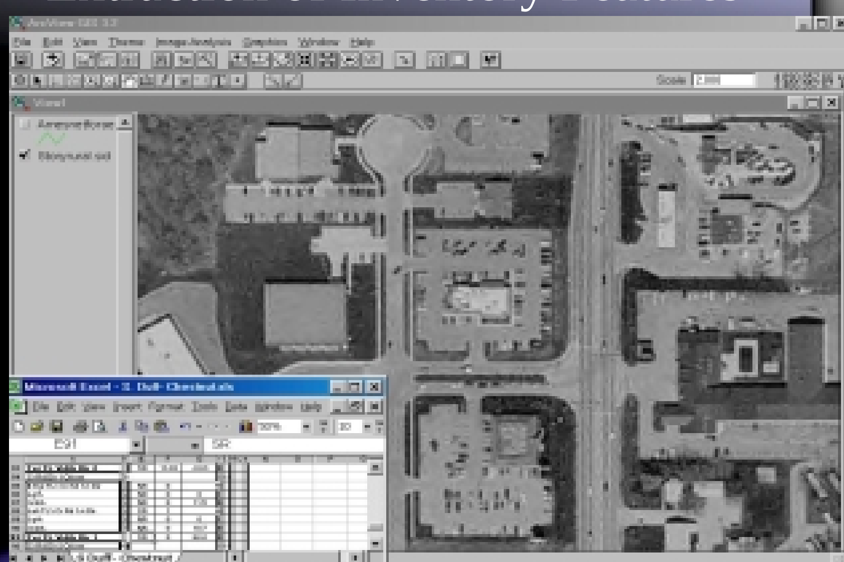
Pilot Study Locations



Extraction of Inventory Features



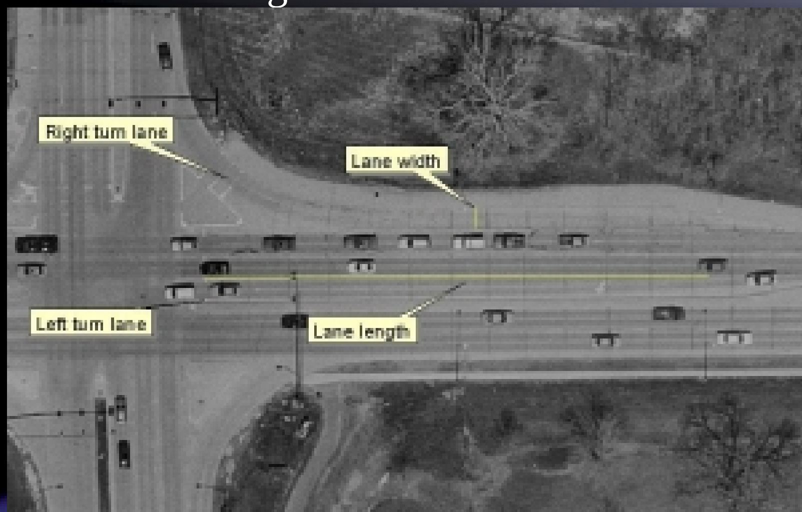
Extraction of Inventory Features



Extraction of features from 2 foot image

Extraction Procedures

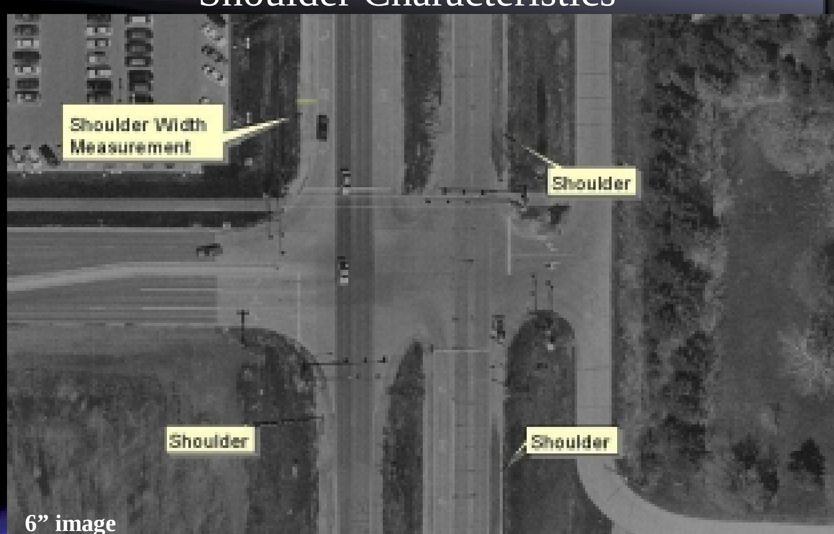
Turning Lane Characteristics



6” image

Extraction Procedures

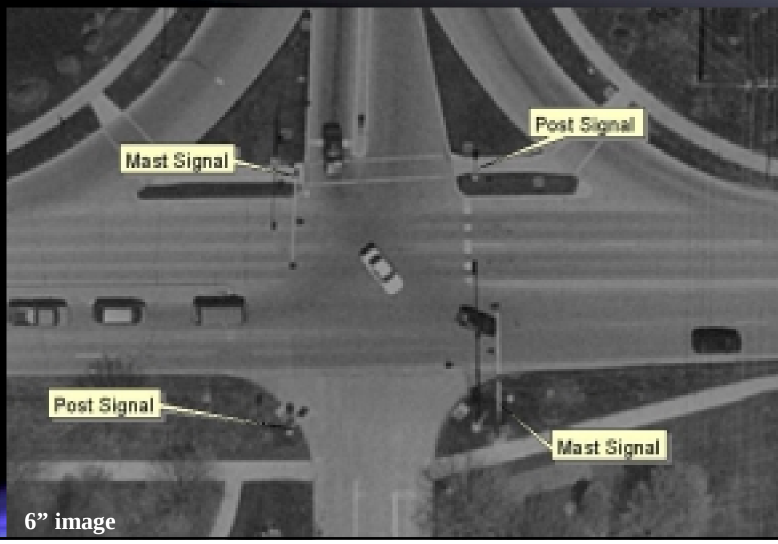
Shoulder Characteristics



6” image

Extraction Procedures

Signal Structure



Performance Measures

- Feature Identification
- Accuracy of Linear Measurements

Feature Identification

- Number of features identified in aerial photos versus ground truth
- e.g. only 44% of the time can correctly identify the number of through lanes (2' resolution)
- All shoulder edges can be identified with 6-inch resolution photos

Feature Identification

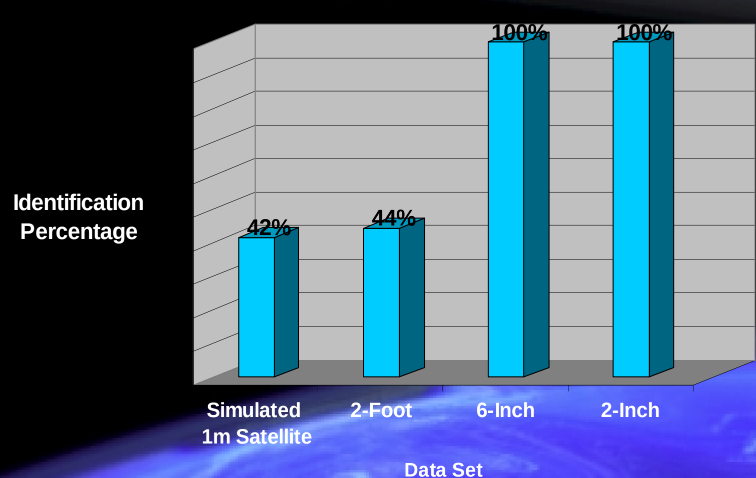
	Simulated 1m Satellite	2-Foot	6-inch	2-inch
Number of Through Lanes	42%	44%	100%	100%
Through Lane Width	<25%	<25%	100%	100%
Shoulder Presence/Type	N/A	30%	100%	100%
Shoulder Width	N/A	0%	100%	100%
Parking Presence/Type	83%	95%	100%	100%
Median Presence/Type	56%	57%	100%	100%
Median Width	56%	57%	100%	100%
Private Access	100%	100%	100%	100%
Comm/Ind Access	100%	100%	100%	100%
Pavement Type	0%	0%	85%	100%
Intersection Design	100%	100%	100%	100%
Land Use	100%	100%	100%	100%

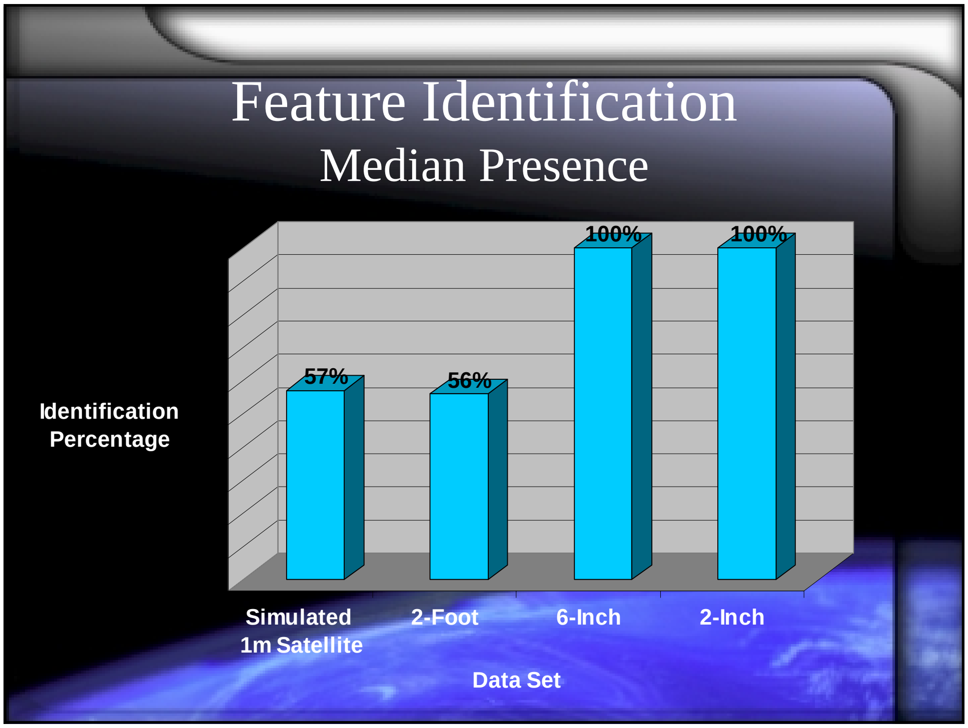
Feature Identification

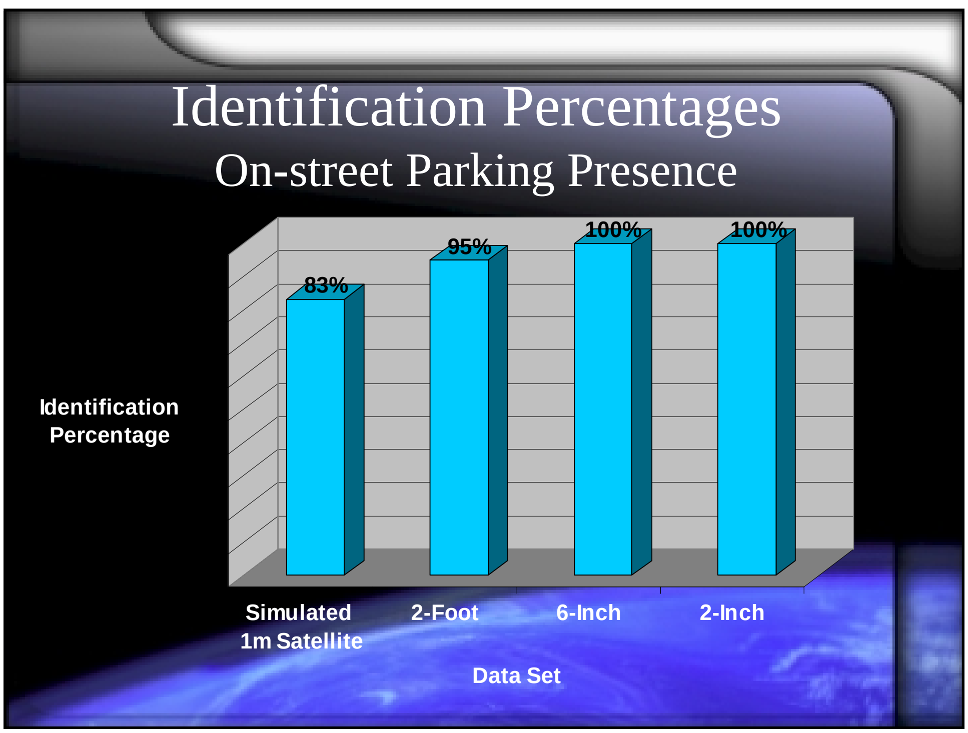
	Simulated 1m Satellite	2-Foot	6-inch	2-inch
Crosswalks	0%	0%	100%	100%
Pedestrian Islands	<25%	<25%	100%	100%
Stop Bars	0%	<25%	100%	100%
Signal Structure/Type	0%	0%	90%	100%
Right Turn Lane Presence	71%	58%	100%	100%
Right Turn Lane Length	57%	58%	100%	100%
Right Turn Lane Width	57%	50%	100%	100%
Left Turn Lane Presence	63%	47%	100%	100%
Left Turn Lane Length	50%	47%	100%	100%
Left Turn Lane Width	50%	37%	100%	100%
Total Roadway Width	100%	100%	100%	100%

Feature Identification

Number of Through Lanes



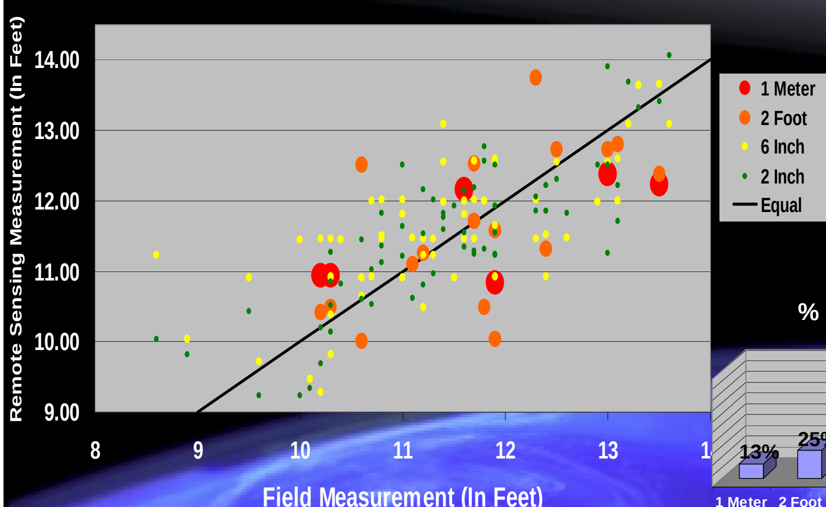

Feature Identification
Median Presence
Identification Percentage
57%
56%
100%
100%
Simulated 1m Satellite
2-Foot
6-Inch
2-Inch
Data Set

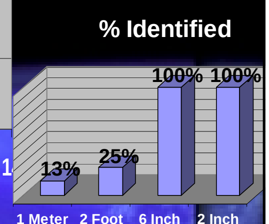

Identification Percentages
On-street Parking Presence
Identification Percentage
83%
95%
100%
100%
Simulated 1m Satellite
2-Foot
6-Inch
2-Inch
Data Set

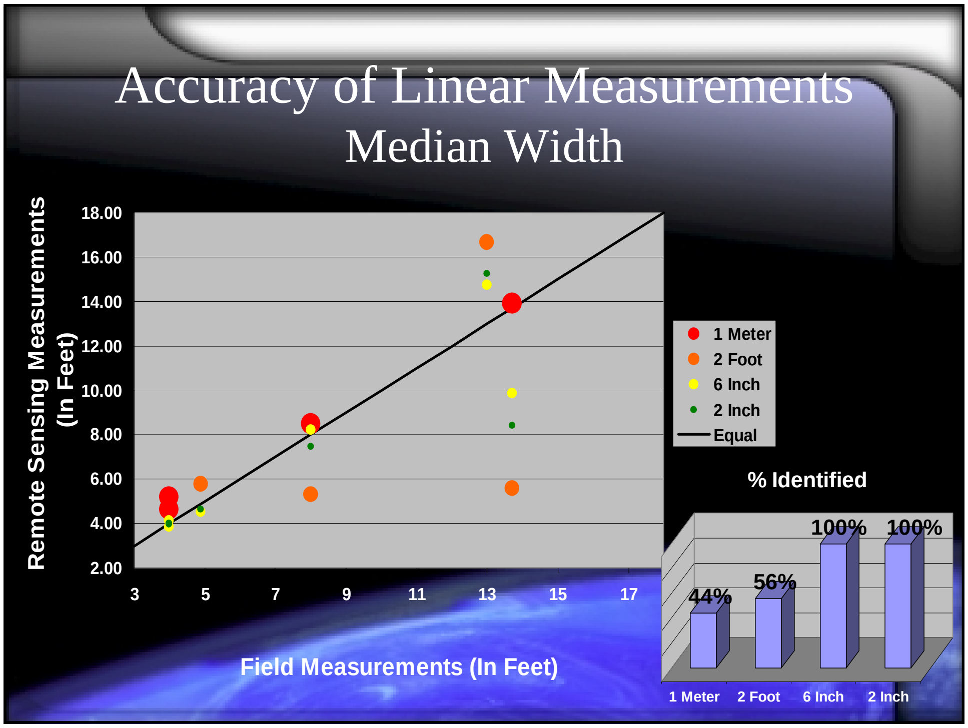
Accuracy of Linear Measurements

- Comparison of extracted measurements to ground truth
  - e.g. 37/67 measurements of individual through lane width were within 6 inches of the true measurement using 2-inch resolution photos
- Recommended accuracies
  - Lane lengths within ± 1 meter (± 3.28 feet)
  - Lane widths within ± .1 meter (± .328 feet)
  - Shoulder widths within ± 0.1 meter (± .328 feet)
  - Median widths within ± 0.1 meter (± .328 feet)

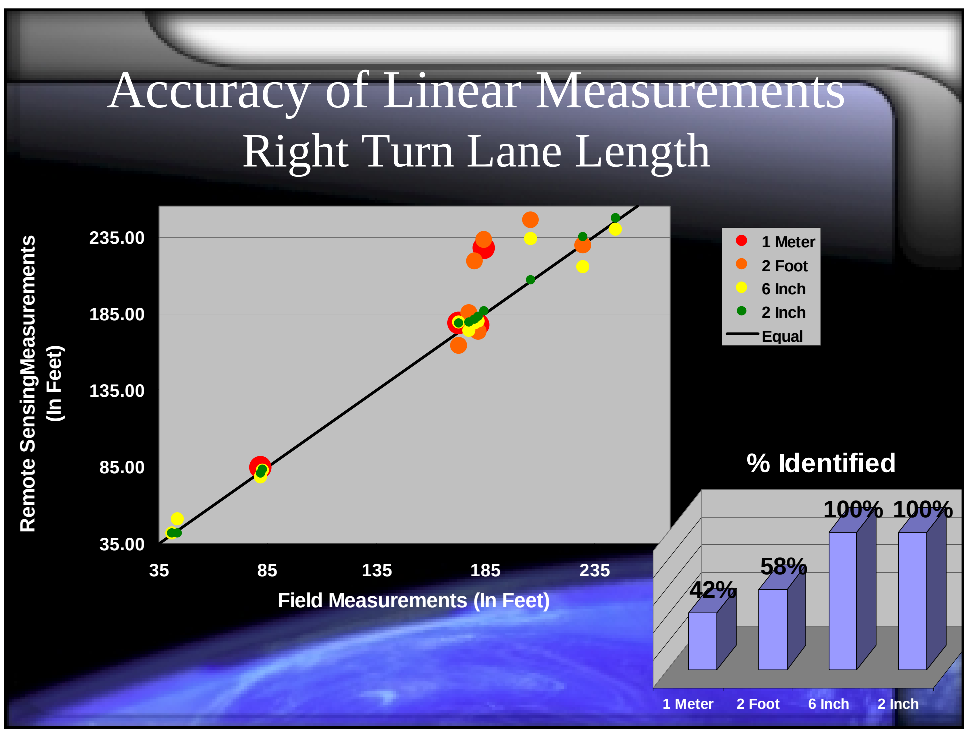
Accuracy of Linear Measurements Through Lane Width



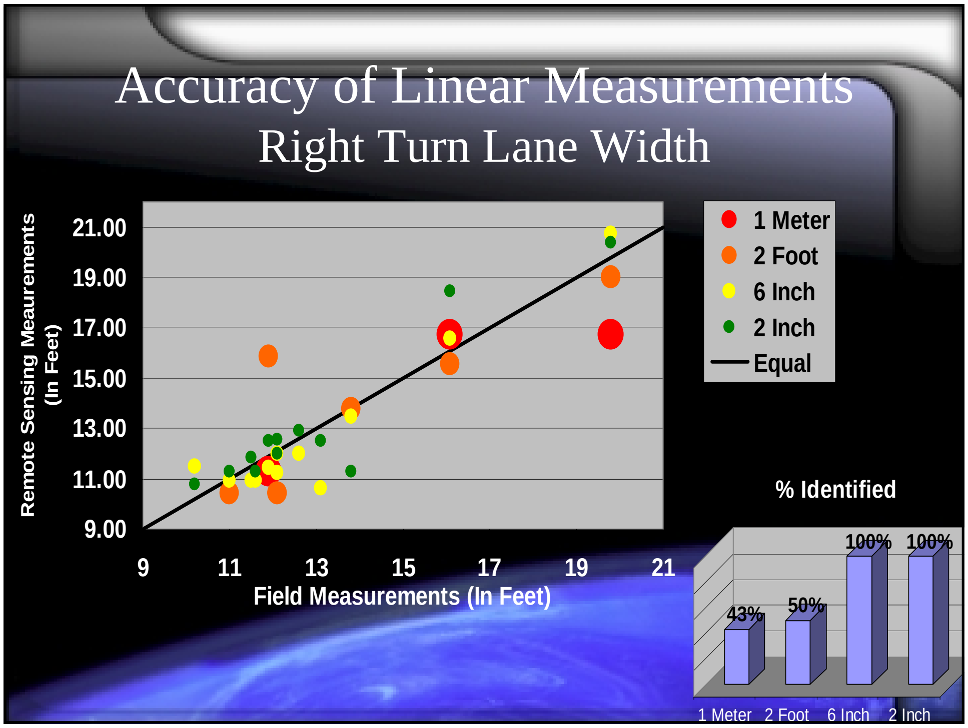


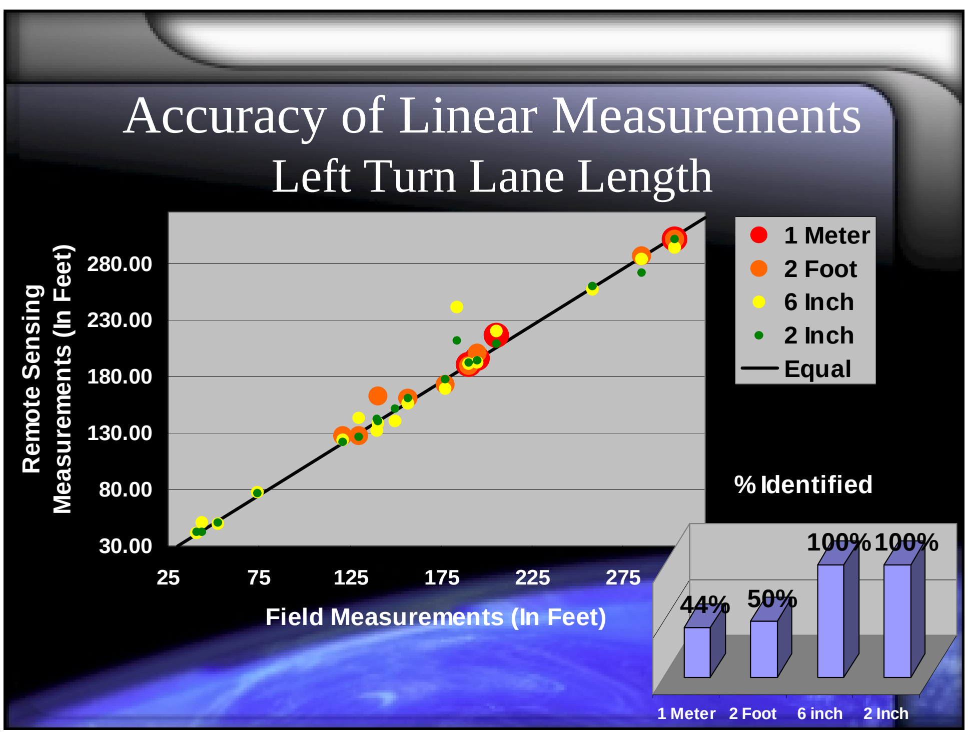


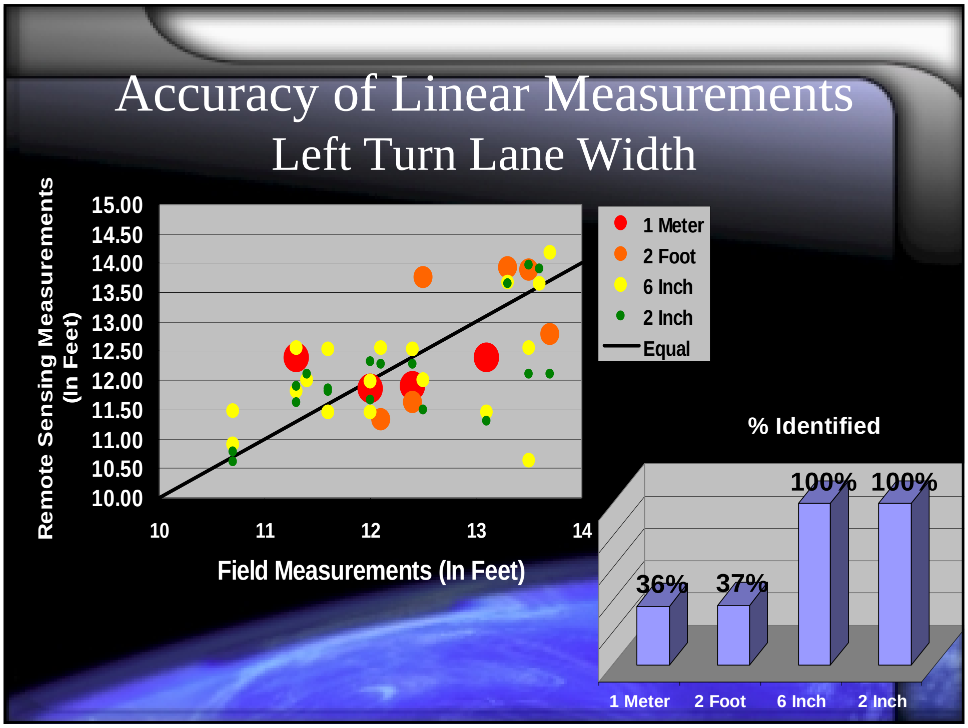
Accuracy of Linear Measurements
Median Width
Remote Sensing Measurements (In Feet)
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
3
5
7
9
11
13
15
17
Field Measurements (In Feet)
1 Meter
2 Foot
6 Inch
2 Inch
Equal
% Identified
44%
56%
100%
100%
1 Meter
2 Foot
6 Inch
2 Inch

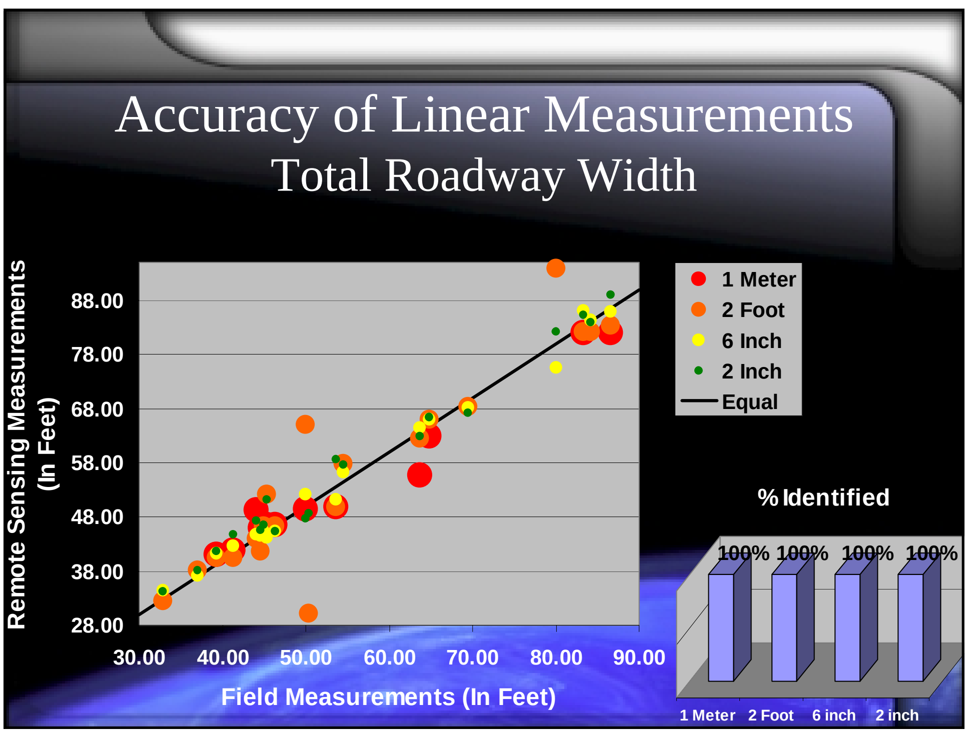


Accuracy of Linear Measurements
Right Turn Lane Length
Remote SensingMeasurements (In Feet)
235.00
185.00
135.00
85.00
35.00
35
85
135
185
235
Field Measurements (In Feet)
1 Meter
2 Foot
6 Inch
2 Inch
Equal
% Identified
42%
58%
100%
100%
1 Meter
2 Foot
6 Inch
2 Inch


Accuracy of Linear Measurements
Right Turn Lane Width
Remote Sensing Meaurements (In Feet)
21.00
19.00
17.00
15.00
13.00
11.00
9.00
9
11
13
15
17
19
21
Field Measurements (In Feet)
1 Meter
2 Foot
6 Inch
2 Inch
Equal
% Identified
43%
50%
100%
100%
1 Meter
2 Foot
6 Inch
2 Inch


Accuracy of Linear Measurements
Left Turn Lane Length
Remote Sensing Measurements (In Feet)
280.00
230.00
180.00
130.00
80.00
30.00
25
75
125
175
225
275
Field Measurements (In Feet)
1 Meter
2 Foot
6 Inch
2 Inch
Equal
% Identified
44%
50%
100%
100%
1 Meter
2 Foot
6 inch
2 Inch


Accuracy of Linear Measurements
Left Turn Lane Width
Remote Sensing Measurements (In Feet)
15.00
14.50
14.00
13.50
13.00
12.50
12.00
11.50
11.00
10.50
10.00
10
11
12
13
14
Field Measurements (In Feet)
1 Meter
2 Foot
6 Inch
2 Inch
Equal
% Identified
36%
37%
100%
100%
1 Meter
2 Foot
6 Inch
2 Inch


Accuracy of Linear Measurements
Total Roadway Width
Remote Sensing Measurements (In Feet)
88.00
78.00
68.00
58.00
48.00
38.00
28.00
30.00
40.00
50.00
60.00
70.00
80.00
90.00
Field Measurements (In Feet)
1 Meter
2 Foot
6 Inch
2 Inch
Equal
% Identified
100%
100%
100%
100%
1 Meter
2 Foot
6 inch
2 inch

Problems/Difficulties

- Different data sources
  - Taken on different days
  - Saved in different formats (.tif, .sid)
  - All sets are panchromatic, no color
- Potential photo errors
  - Atmospheric distortions
  - Camera displacements at time of exposure

Problems/Difficulties

- Vegetation can block the view of features
- Impossible to begin and end measurements on images at the same points as were used in the field
- Pavement markings heavily relied upon for length and width measurements, but these are not repainted in the exact location

Conclusions

- 1-meter and 2-foot images allow identification of
  - Intersection design (4-way, T, etc.)
  - Presence of on-street parking
  - Driveway location/land use
- 2-foot images also allow some identification of:
  - Number of thru lanes/lane width
  - Median presence
  - Turning lane presence/type/length/width

Conclusions

- 6-inch images allow more detailed data to be identified and extracted
  - Lane widths and lengths (through and turn lanes)
  - Shoulder presence/width
  - Signal structures

2-inch images allowed all elements to be identified and measured

Road Network Extraction and Data Integration

GIS-T Symposium

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Center for Transportation Analysis
Oak Ridge National Laboratory
Oak Ridge, Tennessee 37831-6206
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(865) 574-2696

April 9-11, 2001, Crystal City, Virginia

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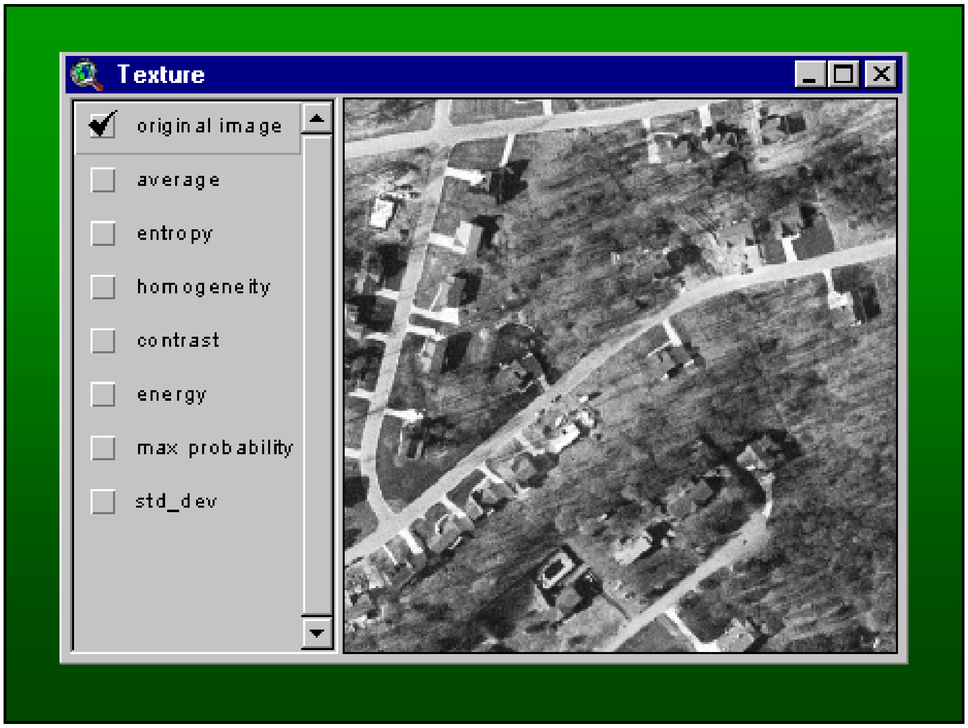
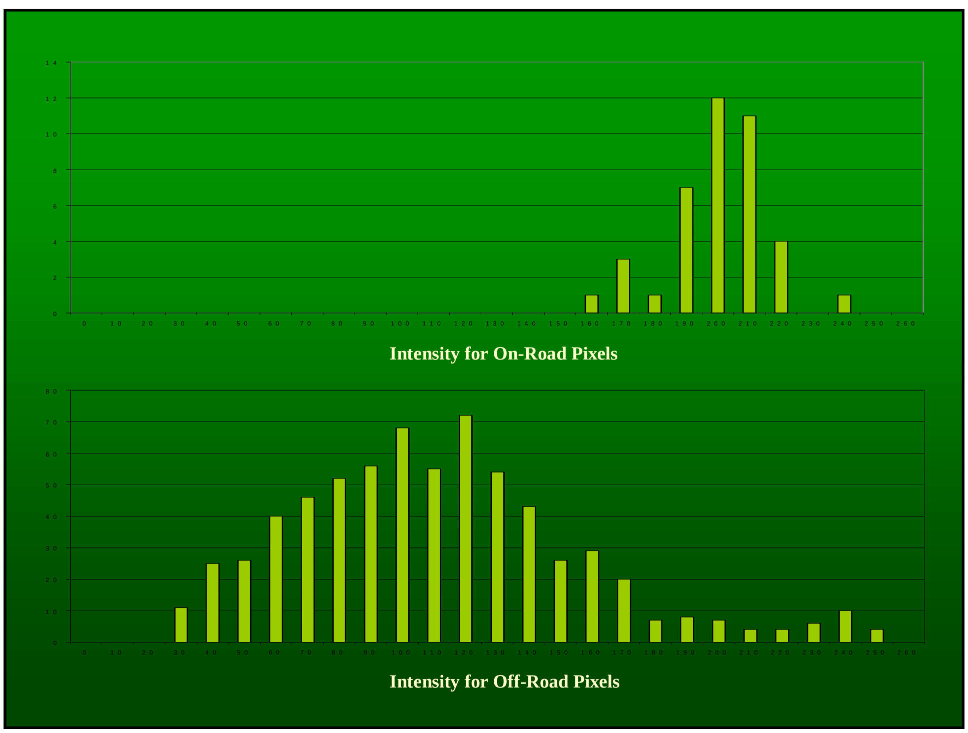
Presentation Outline

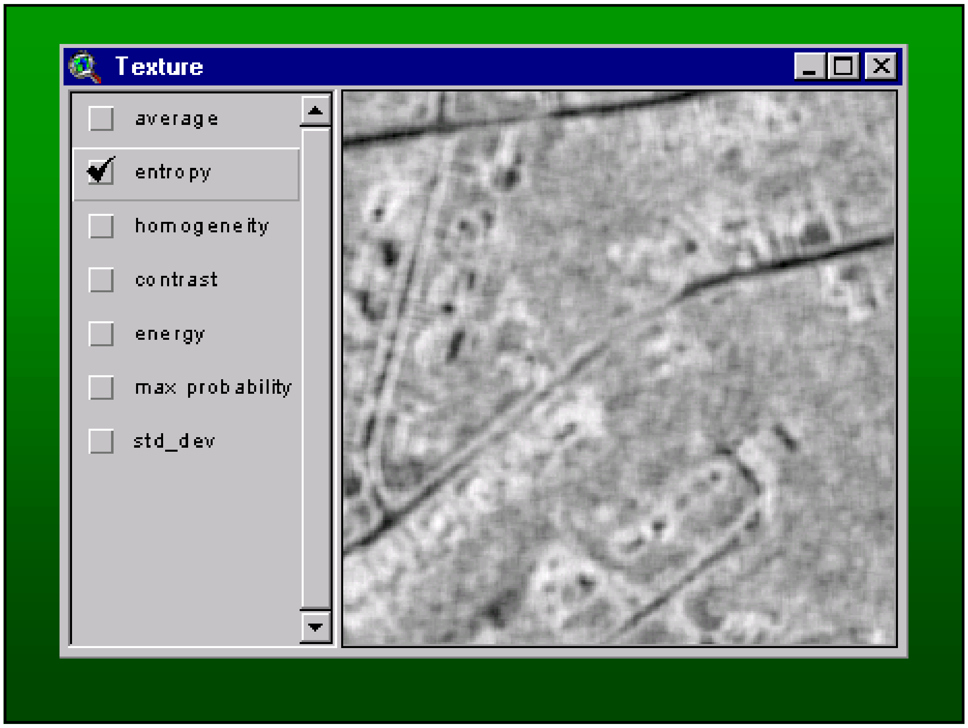
- Road Network Extraction
  - Existing research
  - Road image characteristics
  - Road network extraction
- Data Integration
  - The problem
  - The approach
  - Some results
- Discussions

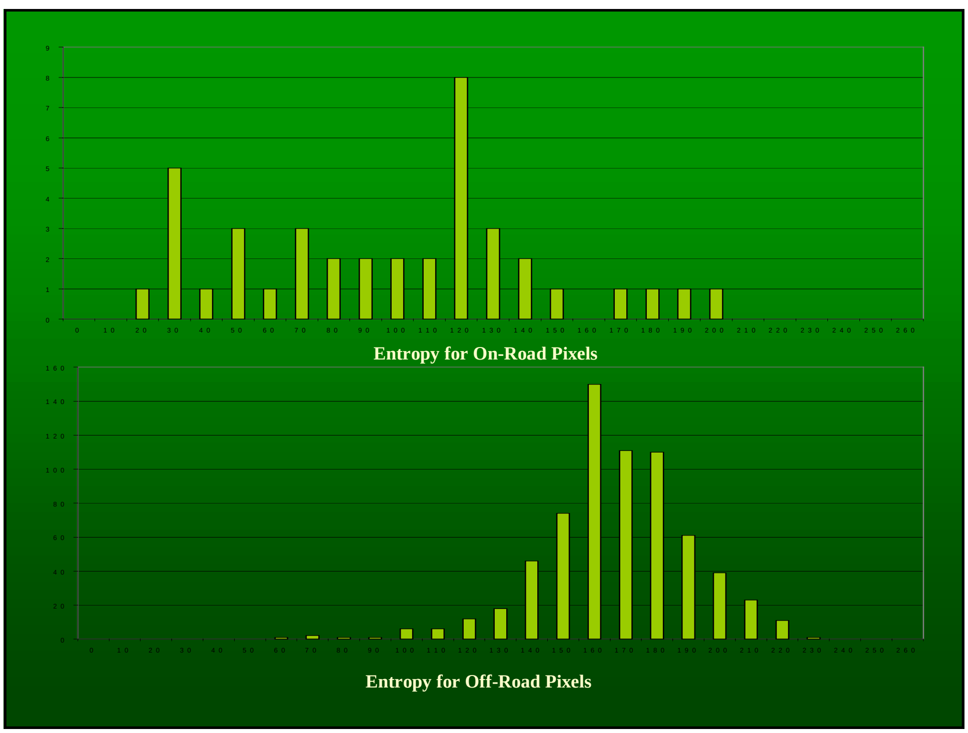
Existing Approaches

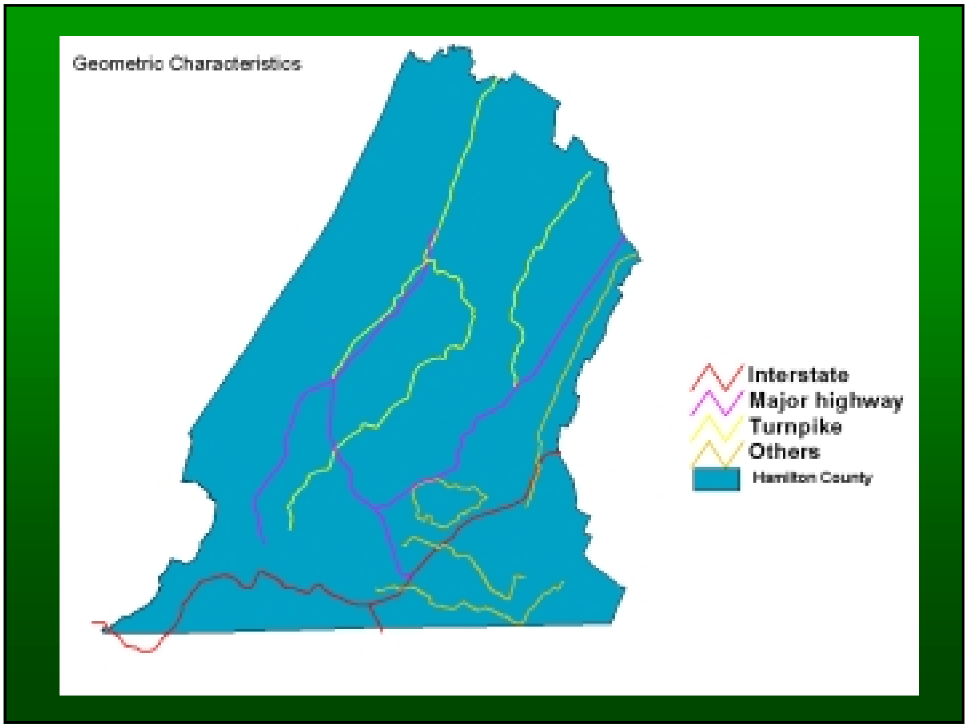
APPROACH	DESCRIPTION
Differential Geometry (Steger)	*Curve fitting, and road pixel linking.*
Gradient Direction Profile Analysis (Wang et al)	*Local gradient computing, ridge profiling, noise removing and ridge thinning.*
Map-Matching with Artificial Neural Networks (Fiset et al)	*Map matching for NN training and template matching for intersection and segment detection.*
Dynamic Programming (semi-automated) (Gruen and Li)	*Road model construction and dynamic programming.*
Geometric Stochastic Modeling (Barzohar & Cooper)	*Geometric probabilistic model construction and road finding with MAP (Maximum a Posteriori Probability).*
Active Testing (Geman and Jedynak)	*Tracking roads through statistical model construction and hypotheses testing.*
Integrated Approach (Zafiropoulos)	*Template matching and least square fitting with the use of techniques of deformable contour models.*


Texture
original image
average
entropy
homogeneity
contrast
energy
max probability
std_dev

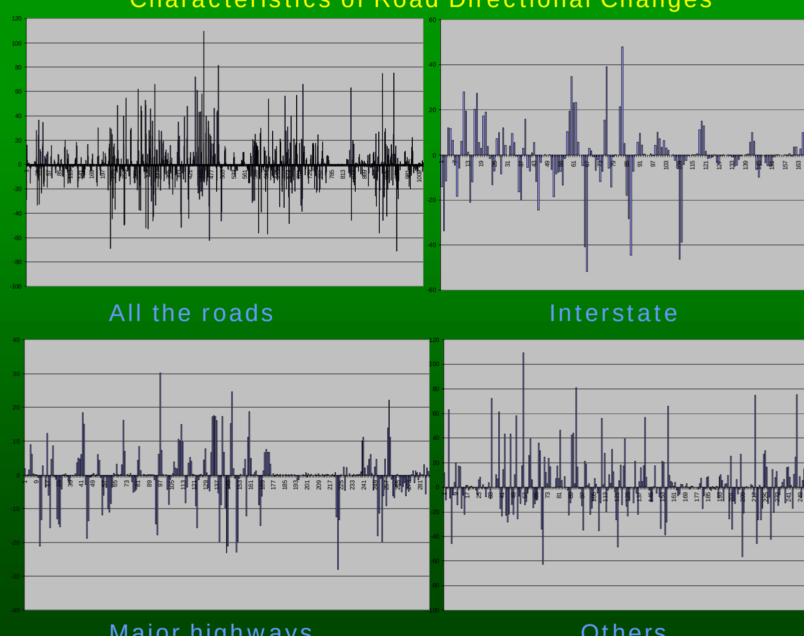

Intensity for On-Road Pixels
Intensity for Off-Road Pixels


Texture
average
entropy
homogeneity
contrast
energy
max probability
std_dev

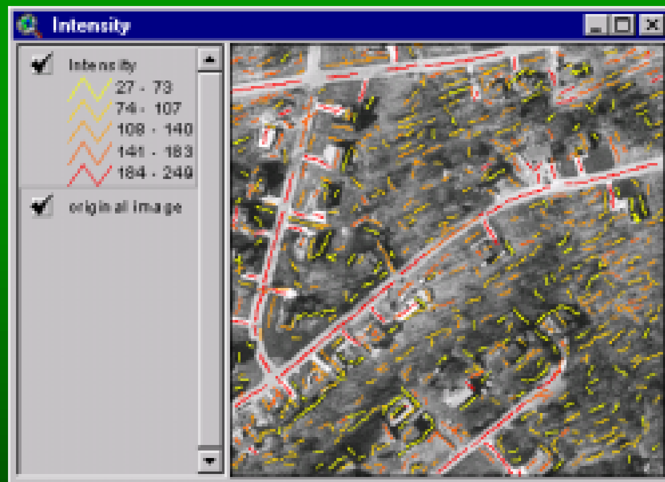

Entropy for On-Road Pixels
Entropy for Off-Road Pixels



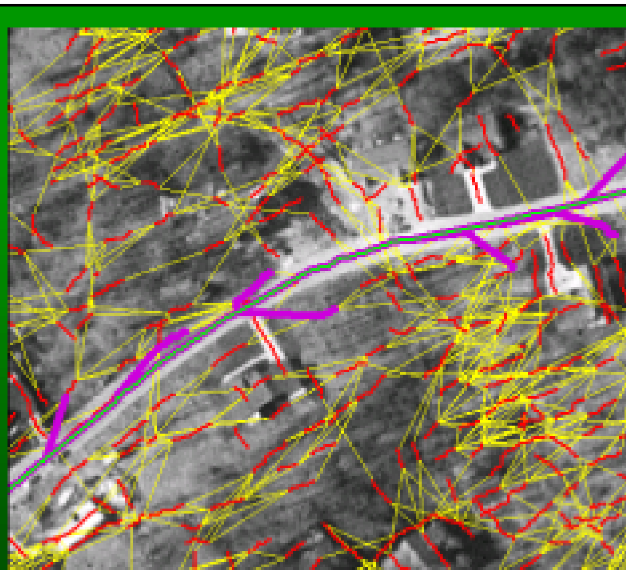
Characteristics of Road Directional Changes



Road Network Extraction



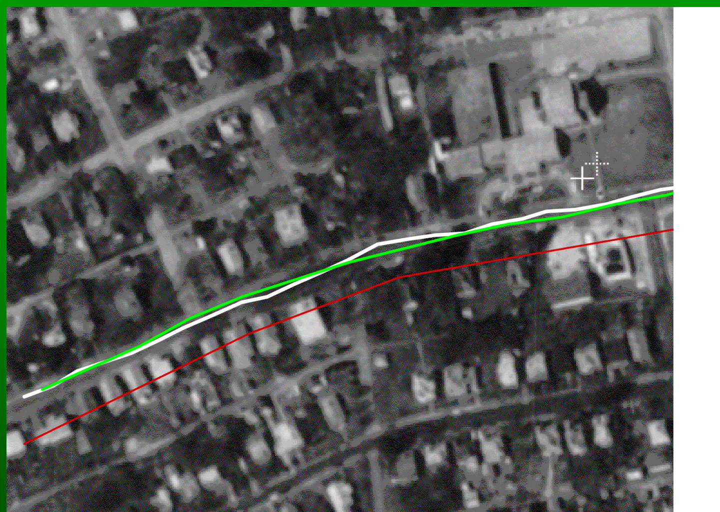
The current road extraction method utilizes two major approaches to start the extraction process: with an image or with an existing map. When starting with an image, it proceeds first with analysis of local image characteristics such as intensity, intensity change, texture and neighborhood connectivity. These characteristics, when formalized, can be used to define a local template, or a feature model. Matching the template with the image, potential features will be extracted.



Matches generated with local template usually have problems. Some of the matches may not represent an intended feature. In other situations, fragmentation can occur for detected elements. To overcome the problem, a feature network is established to group and extract intended features.

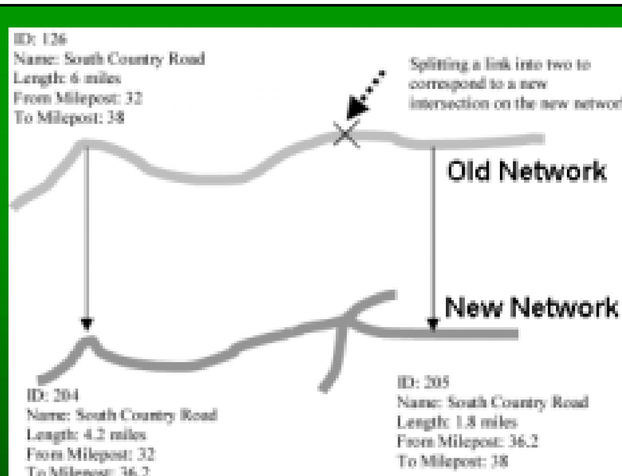
After grouping, potential road segments form hypothesized road candidate. By comparing the characteristics of a hypothesized candidate with the trained road model, identification of a candidate will be established (e.g., all the green lines on the image are identified as roads, purple lines are not).

After extraction, post-processing sometimes is necessary in order to generate smooth centerlines or to measure feature length and width.

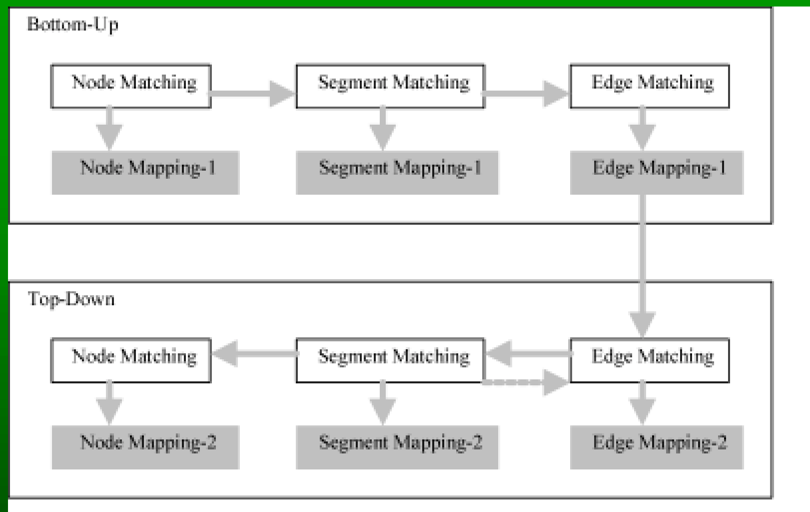


Feature extraction can also start with an existing map. That is, existing maps of road networks can be overlaid on an image. Due to map and/or image distortions, maps and images are not necessarily matched at the first place. The current method can use the map locations as the starting points, then find image locations that correspond to the map. In this way, map geometry can be updated with a newer or more accurate image data sources.

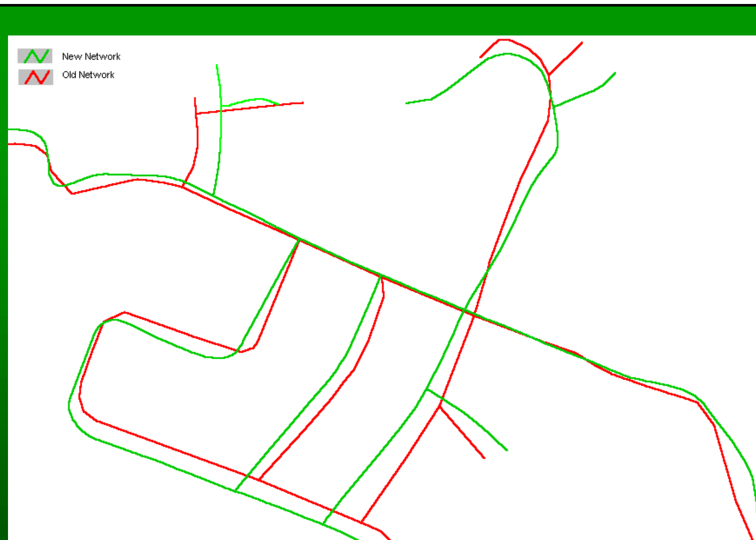
Network Data Integration



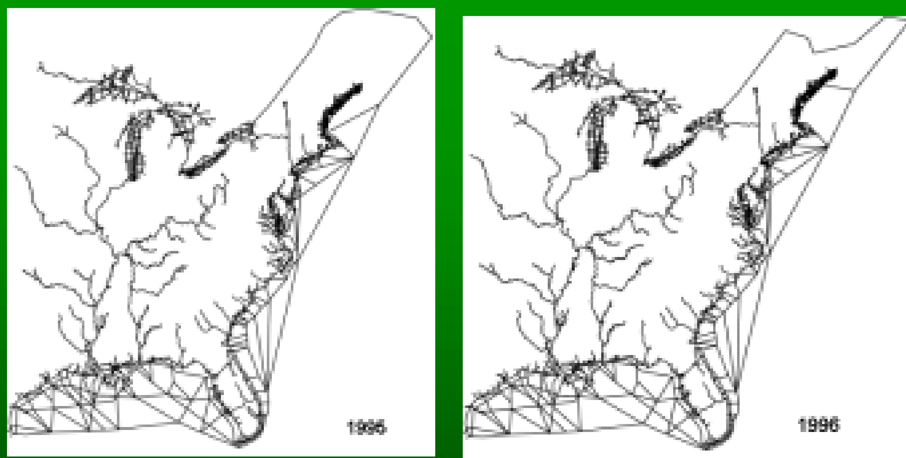
Once feature geometry is updated, fusing data from different sources for the newly obtained feature is another important task. Some of the data may be obtained from an image directly, others may come from field GPS or from an existing database. Data integration in general is a time consuming process if it has to be done manually. As illustrated above, a road on an old map has one link, then on a new map, an addition of another road split the road into two segment. To conflate the attribute from the old map to the new map, the corresponding parts between the old map and the new map must first be identified, then the attributes on the old map may have to be recalculated, then assigned to the new map.



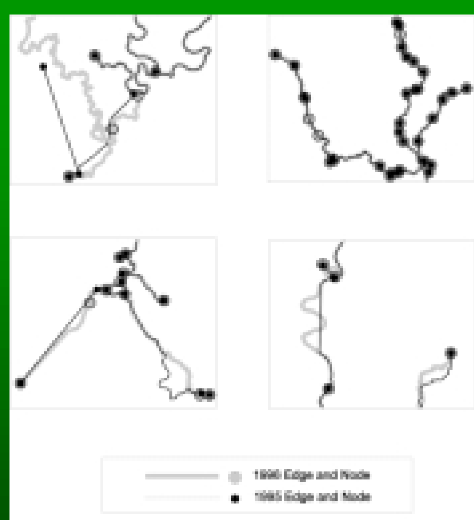
ORNL developed a network matching algorithm that allows two network maps to be matched automatically, and correspondences between two maps can be established at node, segment and link levels. After the establishment of map correspondences, map attributes can be transferred from one map to the other map.



Finding correspondence between two networks is not always an easy task, and in some cases, networks may not match geometrically or topologically. In the case shown above, red lines represent road networks from TIGER file and the green lines are roads obtained from an image. The current method has the ability to handle the geographic and topological differences between the two networks.



The network matching method has been used to match the 1995 and 1996 waterway networks (East U.S.), which have about 4500 nodes and 5000 links. (Data source: U.S. Bureau of Transportation Statistics, U.S. Department of Transportation).



Differences between the 1995 and 1996 networks include changes in node positions and geometry refinement. The current method is able to match 99% nodes and 97% links for the two networks shown in the previous slide.

Discussions

- Road network extraction and network matching are kind of separate procedures, but together they form a nice framework for road network detection, localization and attribution, and can be utilized to develop, update, and maintain spatial databases.
- Many research problems are still out there, such as:
  - Unsupervised road recognition,
  - Changes in resolutions, image types, background, etc.,
  - Network matching with different scales, orientations, and projections.

United States
Census
2000

Geographic Products

Leo Dougherty
Geography Division
Bureau of the Census

Census 2000 Data Products Major Changes

- Wider Product Availability than 1990
- Internet Access- *American Fact Finder*
  - Data and geographic products

What's New in Census Geography for Census 2000

- Census Tracts/Block Numbering Areas (BNA)
  - One program - Census Tracts
- Census Designated Places (CDP)
  - No minimum population
  - Closely settled, named communities

What's New in Census Geography

- Census 2000 Block Numbers
  - 4 Digits - no suffix
    - Allows delineation of more blocks
  - Delineated *AFTER* 2000 Census
    - Reflects more recent feature network
    - Boundaries first Available early 2001 with TIGER/Line 2000

What's New in Census Geography

- **ZCTA™**
  - **ZIP Code Tabulation Area**
    - **Approximate area representations of USPS ZIP Code service areas**
    - **Based on Census 2000 Blocks**
    - **To address difficulties in mapping USPS ZIP Codes**
    - **Estimated count of 31,960**

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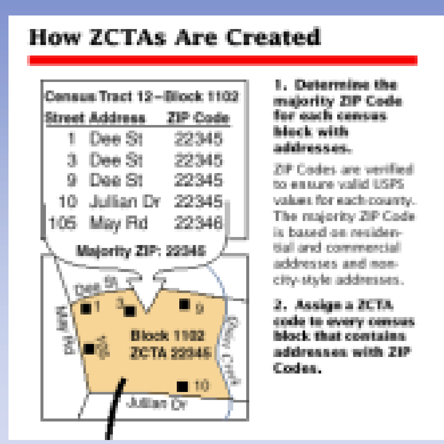
What's New in Census Geography



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What's New in Census 2000 Geography

Urban Area Criteria Change

- **New criteria in *Federal Register* - *March '01***
- **Based on Urbanized Areas and Urban Clusters not Places**
  - Core of Block Groups or Blocks
    - 1,000 or more population per square mile

      PLUS
  - Surrounding blocks with 500 or more density
- **No "Grandfathering" of previous UAs**
- **Info:** www.census.gov/geo/www/ua/ua_2k.html

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What's New in Census Geography

- **Metropolitan Areas**
  - **New Concepts proposed by OMB**
    - Core Based Statistical Area
    - Based on Census 2000 data
    - New definitions will be implemented after 2000 Census data release
    - Initial Census 2000 data will use 1999 MA definitions
- **For further information go to URL:**

www.census.gov/population/www/estimates/masrp.html

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Some Statistics on Census 2000 Geographic Areas

- 280 Metropolitan Areas
- 3,232 County and County Equivalents
- 25,685 Places
- 66,304 Census Tracts
- 211,267 Census Block Groups
- 8,262,363 Census Blocks
- 166,747 Traffic Analysis Zones

Geographic Products:

Tools to Support User Needs

- Redistricting
- Maps to Use with Statistical Reports
- Digital Products for Special Needs

Geographic Products:
The TIGER Data Base

- Topologically
  Integrated
  Geographic
  Encoding and
  Referencing
- The source of ALL census geographic products

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Geographic Products
TIGER/Line Files

- Redistricting Census 2000 TIGER/Line File - ONLINE
  - To support P.L.94-171
  - First View of 2000 Block Boundaries
  - No ZCTA information
  - Distribution ONLINE, DVD, and Custom CD-ROM
- Census 2000 TIGER/Line Files - May/June 2001
  - Redistricting TIGER/Line files but, with ZCTAs and most up-to-date address information
  - Distribution ONLINE, DVD, and Custom CD-ROM

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TIGER/Line Future Releases

- **First "Post 2000" Release**
  - To support U/A and PUMA programs
  - Little Change in format
- **Anticipate Annual Releases After 2002**
  - To support Census Bureau programs
- **MAF/TIGER Modernization Program**
  - Master Address File and TIGER
  - Exploring, with Industry, ways to improve process and accuracy of MAF and TIGER
  - www.census.gov/geo/mod/maftiger.html

1998 to 2000 TIGER/Line Improvements From:

- **Latest Legal Boundaries**
  - Yearly Boundary and Annexation Survey
- **Census Address Listing Operations Updates and LUCA Local Review**
- **Matching USPS Files (incl. ZIP+4)**
- **TIGER Update Operations**

Geographic Products: Maps

- Wide Use of Color
  - ALL map types
- Available as paper copies
  - From the Census Bureau
- Available in electronic formats
  - On the Internet and on Disc

Geographic Products:
Maps For Redistricting

- County Block Maps
  - Show block numbers
  - Show VTDs (voting districts)
- Voting district outline maps
  - With State Legislative Districts (where available)
- Census tract outline maps

Geographic Products:
Maps For Redistricting

- **Format**
  - **Sheet size 33” x 36”**
  - **Adobe PDF**
  - **Guidelines on Web for Plotting**

  http://www.census.gov/ftp/pub/geo/DR/dr_geopr.html
- **Media**
  - **Internet**
  - **DVD**
  - **CD-ROM (Custom order)**

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Geographic Products: Maps
PDF File Capabilities

- **Thumbnail views of Maps**
- **Zoom and Pan**
- **Searchable Text (Census Tract, Place Name & Block Number.)**
- **Print Selected Areas on Map**

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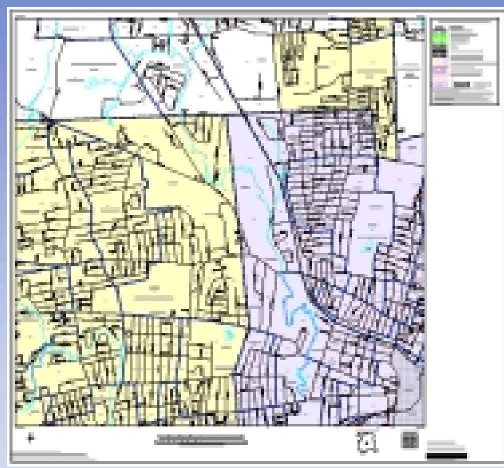
PDF of County Block Map



Go To PDF

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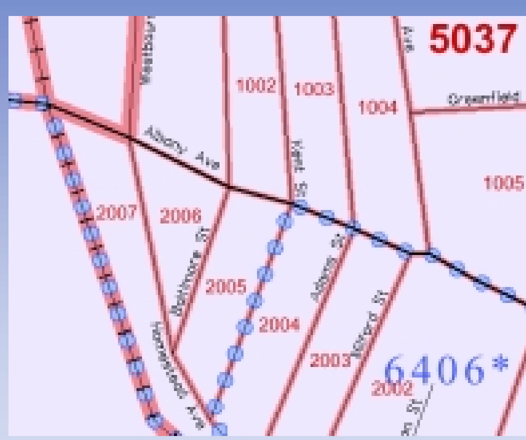
Enlargement of Block Map



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Geographic Products:
Other Large Format Reference Maps

- Census 2000 Block Maps
  - Same “look and feel” as P.L. Maps
  - Released after P.L. Block Maps
  - Without Voting District Information
  - Packaged by governmental entities, i.e counties, American Indian Areas, places, and minor civil divisions

Geographic Products:
Small Format Maps

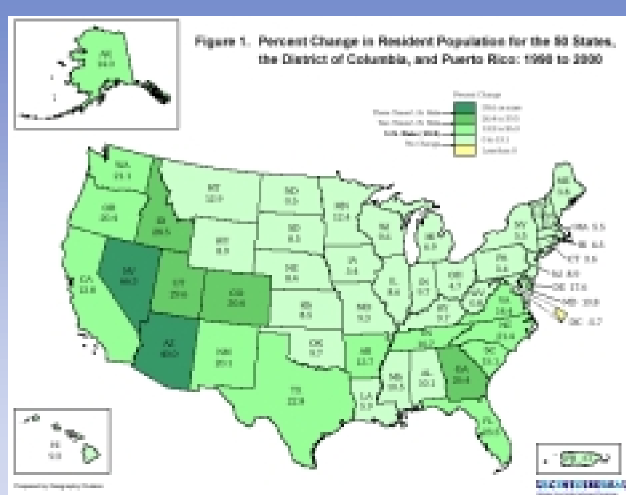
- State/County Subdivision Map
- State/County Outline Map
- State/County Metropolitan Area Outline Map
- Urbanized Area Outline Map
- Congressional District Atlas

Geographic Products: Maps

Statistical or Thematic Maps

- **Display geographic distribution of selected data**
- **Traditional and new topics**
  - **“Night Time” Map, Population density, etc.**
  - **PDF as well as some published paper copies**

Thematic Map: Population Change 1990 to 2000



Product Availability

(All maps released on a flow basis by state)

- **PL94-171 Map suite (Block, VTD/SLD and Tract)**
  - paper plots - March/April 2001
  - PDF files on Web - March/April 2001
- **Census 2000 Block Maps**
  - Post P.L. 94-171 Products
  - Paper plots - May 2001
  - PDF files on Web - May 2001
- **Other Reference Maps**
  - Beginning September 2001

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Geographic Products:

Relationship Files

Relationships (1:1, 1:n, n:1)

- **Summary listing of changes between 1990 and 2000 for tracts & blocks**
- **Not Equivalency Files**
  - Use Census 2000 TIGER/Line to determine details of changes

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Geographic Products:
Relationship Files

2000 Census Tract Relationship Files

- **First Release in May 2001**
  - Addressable street mileage for parts
- **Second Release in October 2000**
  - With population for parts instead of mileage

Geographic Products:
Relationship Files

2000 Census Block Relationship Files

- Release in June 2001
- 1990 Tabulation to 2000 Collection
- 1990 Tabulation to 2000 Tabulation
- 2000 Collection to 2000 Tabulation

Geographic Products:
Boundary Files

- **Generalized from TIGER data**
  - Census 2000 Boundaries online May 2001
  - From the TIGER Page of Census Web Site
- **For use by customer's mapping software for most levels of reporting geography**
- **1990 Boundary Files available NOW**
  - From the TIGER Page of Census Web Site

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Questions About Geographic Products?

E-mail: geography@geo.census.gov

URL: www.census.gov

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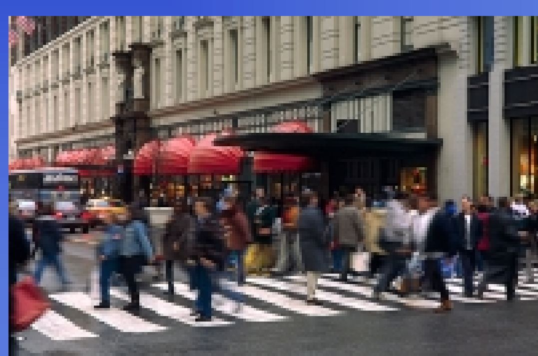
Get Ready to Use Census 2000 Data

John Kavaliunas
Chief, Marketing Services Office
U.S. Census Bureau

United States Census 2000

GIS-T Conference
Arlington, VA
April 11, 2001

On Census Day, April 1, 2000, the U.S. resident population was 281,421,906



Census 2000 Products

Census 2000 data will be released in a variety of formats, media, and detail.

U S C E N S U S B U R E A U

Census 2000 Data Products

Major Product Lines

Products: Summary Files, Profiles,Quick Tables, Geographic Comparison Tables, printed reports, maps, microdata

Media: Internet, CD-ROMs, DVDs, publications

Formats: ASCII, PDF, custom, other

U S C E N S U S B U R E A U

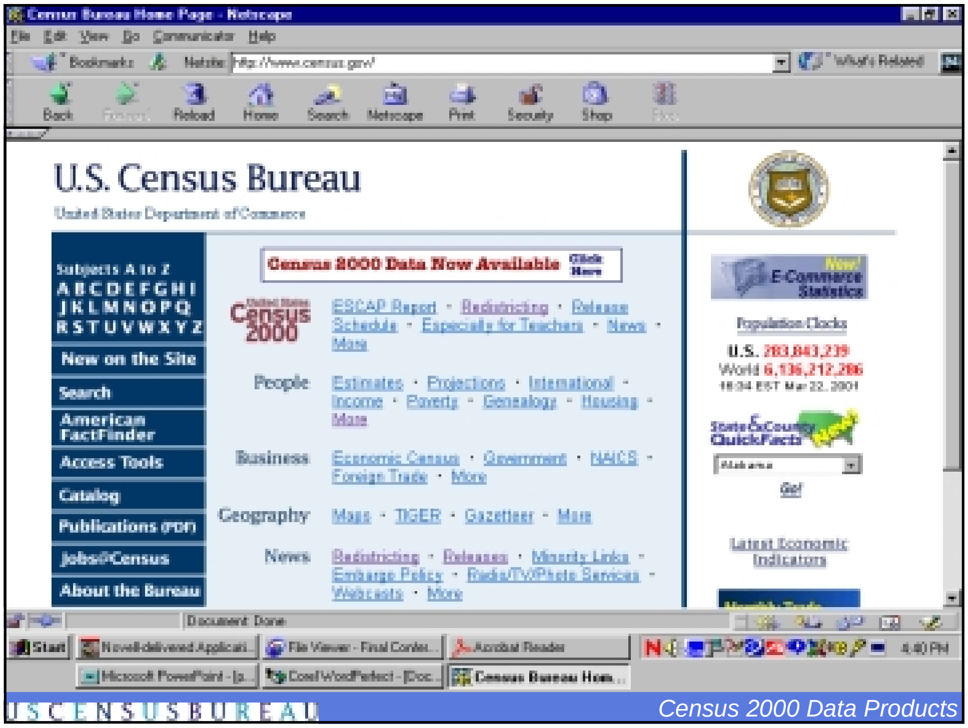
Census 2000 Data Products

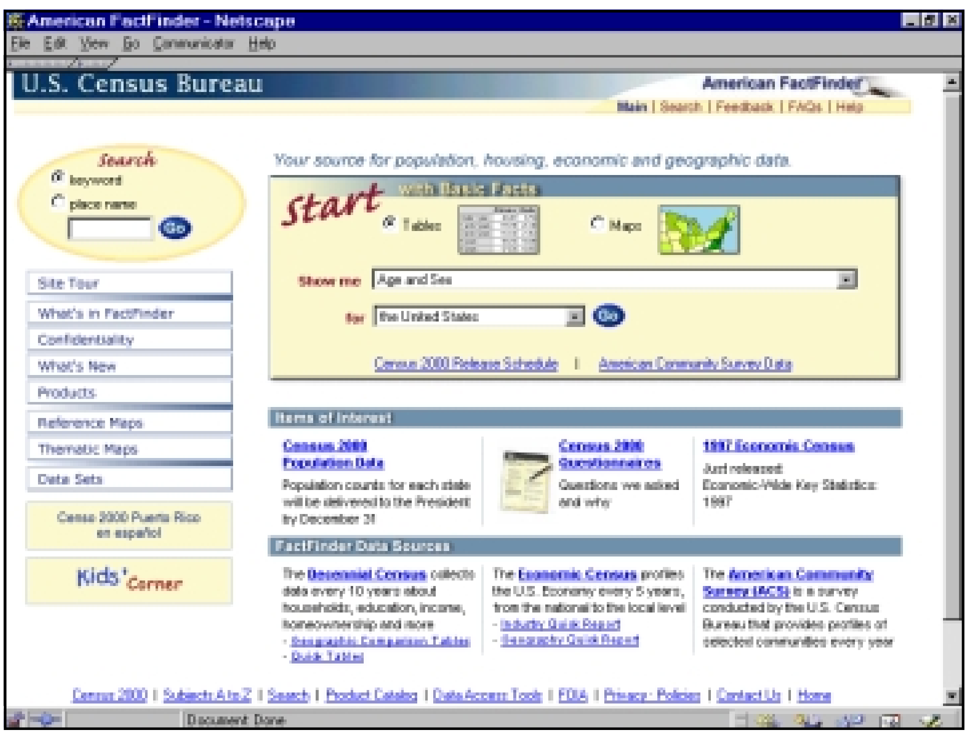
Media

- Internet
- CD-ROM /DVD
- Paper

Internet

- Data released first on American FactFinder
- Community profiles available under QuickFacts
- Printed reports available in Portable Document Format (PDF)
- Maps available in Portable Document Format (PDF)
- Download (FTP) options


U.S. Census Bureau
United States Department of Commerce
Census 2000 Data Now Available
Subjects A to Z
A B C D E F G H I
J K L M N O P Q
R S T U V W X Y Z
New on the Site
Search
American FactFinder
Access Tools
Catalog
Publications (PDF)
Jobs@Census
About the Bureau
People
Business
Geography
News
E-Commerce Statistics
Population Clocks
U.S. 283,843,239
World 6,136,212,286
State & County QuickFacts
Latest Economic Indicators
Census 2000 Data Products


American FactFinder - Netscape
U.S. Census Bureau
American FactFinder
Main | Search | Feedback | FAQs | Help
Search
keyword
place name
Your source for population, housing, economic and geographic data.
Start with Basic Facts
Tables
Maps
Show me Age and Sex
for the United States
Census 2000 Release Schedule | American Community Survey Data
Site Tour
What's in FactFinder
Confidentiality
What's New
Products
Reference Maps
Thematic Maps
Data Sets
Kids' Corner
Items of Interest
Census 2000 Population Data
Census 2000 Questionnaires
1997 Economic Census
FactFinder Data Sources

CD-ROM / DVD

- Redistricting Summary File and 4 series of detailed tables similar to 1990 STFs
- Profiles, Quick Tables, Geographic Comparison Tables, and printed reports (PDF)
- Maps (PDF)
- Access software
- Formats

Paper

- Printed reports
- Maps
- Print on demand

Paper

3 Series of printed reports

- Summary Population and Housing Characteristics
- Summary Social, Economic and Housing Characteristics
- Population and Housing Unit Totals

Census Briefs

Redistricting Summary File

Total population and 18-and-over population by 63 race categories and Hispanic/Latino

Lowest level of geography: block

1 or more CDs per state; 2 DVDs for the entire country

100 Percent Summary Files

Summary File 1

- Counts and cross tabulations
- Counts for detailed race, Hispanic or Latino groups, and American Indian/Alaska Native tribes
- About 300 tables
- Tables repeat (A-I) for major race groups alone, two or more races, Hispanic or Latino, White not Hispanic or Latino
- Geography: block, census tract

100 Percent Summary Files

Summary File 2

- Almost 40 tables reiterated by race, Hispanic/Latino, and American Indian and Alaska Native categories

Sample Data Summary Files

Summary File 3

- Counts and cross tabulations of sample items (income, occupation, education, rent and value, vehicles available)
- About 800 tables of data
- Lowest level of geography: block group

Sample Data Summary Files

Summary File 4

- Tables reiterated by race, Hispanic/Latino, and American Indian and Alaska Native categories, and ancestry

Public Use Microdata SampleFiles

Unaggregated records of responses to Census 2000 with all identifying information removed

Two Files Planned

- 1-Percent National Characteristics File
- 5-Percent State Files
  - ✓ 100,000 population threshold for geography
  - ✓ 10,000 population threshold for characteristics

U S C E N S U S B U R E A U

Census 2000 Data Products

Demographic Profiles

100-Percent data profile

Sample data profiles

U S C E N S U S B U R E A U

Census 2000 Data Products

Tables

Quick Tables

Geographic Comparison Tables

U S C E N S U S B U R E A U

Census 2000 Data Products

Census Transportation Planning Package

Special tabulations of travel-related Census 2000 data by traffic analysis zone

Place of work, place of residence, work flows

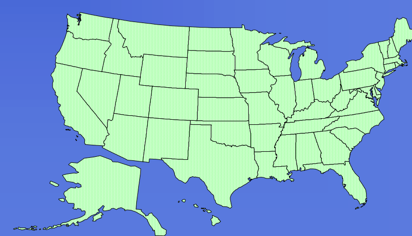
Autumn 2002-Summer 2003

U S C E N S U S B U R E A U

Census 2000 Data Products

Maps and Related Products

- Census 2000 TIGER/Line Files
- Census Block Maps (County and Governmental Units)
- Census Tract Outline Maps
- Boundary Files



Timeline for Census 2000 Data

- December 31, 2000: Official apportionment counts
- April 1, 2001: Data for 63 race groups and Hispanic/Latino by block
- Summer 2001: 100-percent counts and characteristics
- Summer 2002: Sample data products

How to Obtain Census 2000 Data

Census Bureau

- http://www.census.gov
- Census Bureau's Customer Service Center (301-457-4100)

Census 2000 Data Products

Cost of Census 2000 Products

Internet	Free
CD-ROMs	$50
DVDs	$60

Census 2000 Data Products

How to Obtain Census 2000 Data

The U.S. Government Printing Office will sell Census 2000 printed reports.

U S C E N S U S B U R E A U

Census 2000 Data Products

Other Sources of Census 2000 Information

State Data Centers

Census Information Centers

Depository Libraries

Census Bureau Regional Offices

U S C E N S U S B U R E A U

Census 2000 Data Products

Census 2000 Data Products

For more information, visit us at

http://www.census.gov

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Census 2000 Data Products

GIS-T

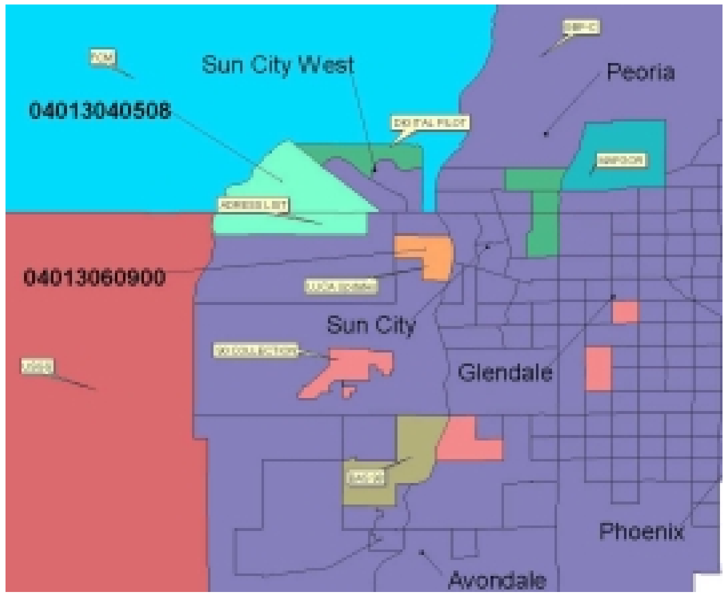
April 11, 2001

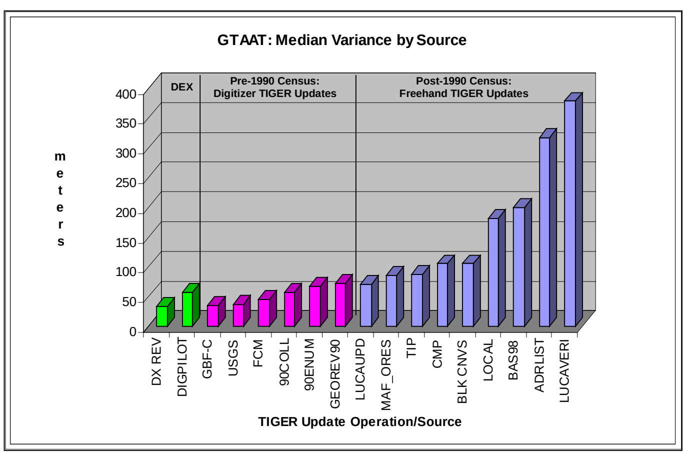
GPS TIGER Accuracy Analysis Tools Evaluation & Test Results

John S. Liadis
TIGER Operations Branch
GEOGRAPHY DIVISION

GTAAT Analysis

- Nov 1999 thru April 2000
- 8 Test Sites
- 6,850 road intersections
- variety of TIGER update sources
- detailed results available on the Census Geography TIGER web page


Sun City West
Peoria
04013040508
04013060900
Sun City
Glendale
Phoenix
Avondale

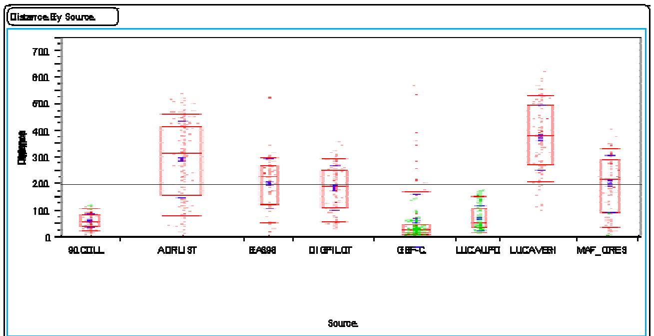


GTAAT: Median Variance by Source
DEX
Pre-1990 Census: Digitizer TIGER Updates
Post-1990 Census: Freehand TIGER Updates
meters
0
50
100
150
200
250
300
350
400
DX REV
DIGPILOT
GBF-C
USGS
FCM
90COLL
90ENUM
GEOREV90
LUCAUPD
MAF_ORES
TIP
CMP
BLK CNVS
LOCAL
BAS98
ADRLIST
LUCAVERI
TIGER Update Operation/Source

OPERATION/SOURCE	Observations	Median	Mean	Process
90 Collection	84	186.12	201.31	Tablet
90 Enumerator Updates	488	216.81	287.51	Tablet
Address List	170	1039.35	962.46	Freehand
BAS 98	80	651.91	593.97	Freehand
Block Canvass	62	342.49	415.79	Freehand
CMP	109	341.40	358.57	Freehand
Digital Pilot	370	185.95	295.37	Direct
DEX Review	60	108.38	161.27	Direct
FCM	862	147.59	243.59	Scanned
GBF-C	1874	114.37	177.98	Scanned
GEO Review 90	137	235.56	290.66	Tablet
LOCAL	53	593.83	584.83	Freehand
LUCA Updates	88	228.92	290.96	Freehand
LUCA Verification	110	1239.86	1205.04	Freehand
MAFGOR	577	279.07	359.25	Freehand
RSTUCT3	55	225.36	288.33	
TIP	270	283.45	385.90	Freehand
USGS	1328	120.36	194.20	Scanned
Others	74	173.59	211.06	Varies
TOTAL	6851	166.53	281.07	Varies

SITE	Observations	Median	Mean	High Tract	Low Tract
Maricopa	845	529.92	632.72	732.41	110.85
Sacramento	856	240.63	293.43	248.55	220.14
Hillsborough	614	122.90	191.57	148.22	106.33
St. Tammany	606	139.62	273.27	188.22	114.93
Clark	981	180.15	208.50	199.37	143.21
Delaware	483	266.30	348.68	N/A	N/A
York	804	100.29	169.06	109.91	84.74
Windham	1662	133.09	209.59	173.13	90.42
TOTAL	6851	166.53	281.07	732.41	84.74

Distance By Source



Quantiles

Level	minimum	10.0%	25.0%	median	75.0%	90.0%	maximum
90COLL	3.24	20.208	38.38	58.19	87.2	108.239	121.23
ADRLIST	6.4	80.319	158.1725	318.795	420.1775	482.01	548.48
BAS98	5.13	52.04	119.515	227.7	287.835	298.27	523.93
DIGPILOT	33.03	57.204	110.99	180.39	253.54	293.706	304.15
GBF-C	2.03	10.828	17.62	28.35	44.13	171.94	574.04
LUCAUPD	13.91	19.784	34.31	59.15	108.57	154.024	175.99
LUCAVERI	103.04	208.192	273.55	382.88	495.85	593.47	628.57
MAF_CRES	7.47	34.872	91.895	215.04	289.54	335.472	405.72

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean
90COLL	83	61.109	30.589	3.358
ADRLIST	170	298.357	145.276	11.142
BAS98	69	199.600	97.838	11.764
DIGPILOT	111	183.994	84.928	8.061
GBF-C	113	61.247	99.551	9.365
LUCAUPD	60	70.252	48.307	6.236
LUCAVERI	107	374.342	123.905	11.978
MAF_CRES	85	201.078	110.493	11.985

Future Spatial Accuracy Evaluation

- Working with NGS to develop digital file and imagery QA procedures
- 2000 TIGER/Line enhancements using imagery
- Develop geographic digital reference information system
- Establish additional digital exchange partnerships.